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A study of current world telecommunications and a projection of the future

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THESIS

A STUDY OF CURRENT WORLD
TELECOMMUNICATIONS
AND A PROJECTION OF THE FUTURE

by

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Telecommunications today are important factor in economic and social progress. The last decades of the 20th century and the early years of the 21st have been characterized as the Information Age. Telecommunications, the movement of information through distances, is absolutely critical to the economic and military survival of nations. This thesis is an attempt to predict the future of telecommunications, by studying and analyzing the past and present. First it examines the meaning of telecommunications today and some basic of information transmission. The current status of telecommunications is then presented, by examining the regional profiles as they are divided by the International Telecommunications Union. A number of statistical studies are given, which present a thorough picture of current world telecommunications. In an effort to predict future industry trends, the competition among the three largest telecommunications markets, U.S.A., Japan and European Community is also considered, by looking at their present telecommunications industry, the efforts they make to improve their technology and their plans for future investment. Finally some major technological trends including B- ISDN, the use of fiber technology in the communications loop and the use of solitons are examinied. The new Metropolitan Area Network protocol, FDDI-II is also reviwed.

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A Study of Current World Telecommunications and a Projection of the Future

by

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ABSTRACT

Telecommunications today are important factor in economic and social progress. The last decades of the 20th century and the early years of the 21st have been characterized by many as the Information Age. Telecommunications, the movement of information through distances, is absolutely critical to the economic progress and military survival of nations.

This thesis is an attempt to predict the future of telecommunications, by studying and analyzing the past and present. First it examines the meaning of telecommunications today and some basic ways of information transmission. The current status of world telecommunications is then presented, by examining the regional profiles as they are divided by the International Telecommunication Union. A number of statistical studies are given, which present a thorough picture of the current world telecommunications.

In an effort to predict future industry trends, the competition among the three largest telecommunications markets, U.S.A., Japan and European Community is also considered, by looking at their present telecommunications industry, the efforts they make to improve their technology and their plans for future investment.

Finally some major technological trends including Broadband ISDN, the use of fiber technology in the telecommunications loop

and the use of solitons are examined. The new Metropolitan Area Network protocol, FDDI-II is also reviewed.

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I. INTRODUCTION

A. OBJECTIVES OF THESIS

This thesis is an attempt to predict the direction that world-wide telecommunications development will take in the future. Day after day, people and governments become more aware of the important role played by telecommunications in the world's economic and social development. An outlook of the present state of the world's telecommunications may help to ascertain future trends and goals of the telecommunications industry.

An effort is made to analyze the current status of telecommunications industry around the world, by studying information and data concerning present and future telephone rates, investment, technology application plans, performance of telecommunications carriers around the world, and several statistical tables. These tables present the present and projected future competition among the telecommunications leaders. Through this information and statistical data this thesis attempts to predict the path telecommunications industry will take in the future.

B. BACKGROUND

Due to enormous technological and industrial development, the telecommunications industry worldwide has changed

dramatically since the basic "T1" line was introduced in 1962. The range and the speed of these technical changes required private corporations, national monopolies, and international regulators, to change and adapt to new requirements in the market.

As the need for quickly produced information starts to dominate people's lives, and the need for faster production, transmission, reception and processing of that information becomes more urgent, the interest in telecommunications technology and services increases. According to the Telecommunications Industry Research Center (TIRC), world expenditures for telecommunications products in 1987 were $109 billion U.S. dollars. This number is expected to reach $243 billion by the end of 1995. [CONTEC89]

Telecommunications began to change the world we live in with the invention of telegraph and telephone, and promises even greater changes. The United States, Japan, and the European Community, the three leading forces in telecommunications industry, make efforts to use common specifications, exchange technology information and reach agreements in an attempt to work together towards a common telecommunications future. The converging technologies of telecommunications and computers, along with the recent revolution in transmission techniques such as digitization, fiber optics and satellites, have made a reality of total and global instant communications.

Advances in technology have resulted a great variety of telecommunications products and services around the world. The result is that small and medium size companies are forced to consider joint ventures and to try to open new markets in order to keep in touch with fast technological development and a growing level of investment required for research.

The same situation holds true for government monopolies and regulatory agencies worldwide which are forced to compete in a global telecommunication industry. In some countries, legislation controls are in place to protect the rights of individual citizens, national security or the national telecommunication market. Many countries also try to help domestic equipment manufacturers, conserve foreign currency reserves and aid local employment. This nationalistic means of protection becomes difficult as international networks are used to transmit voice and data across vast distances. As more businesses become international, the telecommunications markets become more competitive and less regulated.

C. ORGANIZATION OF THE THESIS

The first part this thesis looks at the present state of the telecommunications industry and the efforts made by different countries and world organizations towards international regulation and cooperation. The current situation in the different regions of the world is considered later, along with the efforts made by each country to move

closer to a better future. At last, the promises of tomorrow's technology is examined, by focusing on the competition and the cooperation among the leading forces in telecommunications industry.

II. MEANING OF TELECOMMUNICATIONS

A. THE NEED FOR TELECOMMUNICATIONS

During the last century, telecommunications have grown into one of the largest industries in the world. The 20th century is characterized by the development of telecommunications techniques such as telegraphy, telephony, radio, television and computer. These developments made it possible to produce, communicate, process and store a great deal of complex information, that could not be handled by conventional means. They also resulted a remarkable evolution of the human society, where production of information plays a more important role than conventional industrial production.

Today telecommunications, along with economic and industrial growth, are major parts of the same circle, each triggering the other for further expansion. They are a means to ensure efficient management and a pre-requisite of social and economic progress. [ITU91]

B. COMMUNICATIONS AND INFORMATION

There have been many attempts to define the meaning as well as the importance of the words **Communications** and **Information**. Since the beginning of history the first efforts made by men to communicate were to exchange information. Since then the two words became inseparably linked.

In one of ITU's latest conventions, **communications** or **telecommunications** were described as

> any transmission, emission or reception of signs, signals, writing, images or sounds, or intelligence of any nature by wire, radio, optical or other electromagnetic systems.

The Oxford English Dictionary defines **information** as

> knowledge communicated concerning some particular fact, subject or event; that of which one is appraised or told; intelligence; news. [ITU91]

One of the first successful telecommunication efforts in history was in 490 B.C., when the Athenian general Miltiades, after the victorious fight of the Greeks against the Persians in Marathon, succeeded in warning, by fire signals, his countrymen back in Athens about the Persians attempt at a second landing in south Athens. Throughout history there have been many attempts for fast and long distance communication. The first real technical breakthrough was the invention of the telescope, succeeding in the development of the optical telegraphy. [ANDREWS89]

1. Telegraph

The invention of the telegraph, in the early 19th century, can be considered as the first successful attempt to transmit information on a wire. It was revolutionary in that transmission distance was no limited in the visual horizon, by using wire length and elctrical resistance. The early attempts of sending electrical signals through a wire circuit led, in

1832, to Samuel Morse's idea of creation of the first telegraph industry. Morse's idea was to

> use electromagnets, operated at a distance by making and breaking the current in a battery-powered circuit, to move a pencil, which would make marks on a moving strip of paper. [ANDREWS89]

2. Telephone

The telephone is today the most common telecommunication technology. It is a device that converts human voice (audible sound) to an electrical signal and back again. Through its more than 100 years of history the telephone has developed into one of the most useful appliances. Many features have been added to the first telephone, and today's new telephones can redial, remember and talk, and sometimes even can see the person on the other line.

3. Radio Communication

Table I ELECTROMAGNETIC FREQUENCY SPECTRUM

Frequency	Wavelength (m)	Designation
3 Hz - 3 KHz	10^8 - 10^5	Extrem. Low Freq.(ELF)
3-30 KHz	10^5 - 10^4	Very Low Freq.(VLF)
30-300 KHz	10^4 - 10^3	Low Freq. (LF)
300 KHz - 3 MHz	10^3 - 10^2	Medium Freq. (MF)
3-30 MHz	10^2 - 10	High Freq. (HF)
3-300 MHz	10 - 1	Very High Freq(VHF)
300 MHz - 3 GHz	1 - 10^{-1}	Ultrahigh Freq(UHF)
3-30 GHz	10^{-1} - 10^{-2}	Superhigh Freq(SHF)
30-300 GHz	10^{-2} - 10^{-3}	Extremly High (EHF)
10^3-10^7 GHz	$3x10^{-5}$ - $3x10^{-9}$	Infrared,visible light,ultraviolet

Radio Communication is any kind of communication that uses the earth environment, atmosphere or water, and the Radio Frequency Band as the medium, in order to transmit a message. The Radio Frequency Band covers frequencies less than 3 KHz, used for worldwide military and submarine communication up to frequencies more than 300 GHz, used for satellite and Space Links.

a. Microwave Transmission

Microwave transmissions are line-of-sight and take place in the 3 to 20 Ghz range. Telephone, data and voice traffic and television are the most common applications of microwave transmission technology.

b. Satellite Transmission

Satellite transmissions are a type of microwave communication. The first and the last station are the transmitting and receiving earth stations, with one or more intermediary "Satellite Amplifier" stations. Usually the satellites are positioned about 22,300 miles in space in order to maintain a relative fixed position and retransmit signals of one earth station to another. Satellite transmissions usually take place in the 3 to 8 GHz range.

c. Cellular Radio Transmission

Cellular Radio is another application of Radio transmission and is used to provide mobile telephony. The Cellular Network consists of a System of UHF Band Antennas

connected to a Mobile Central Telephone Office through Land Lines.

4. Computer and Data Networks

The tremendous development of computers and the enormous amount of information that today is available and needs to be stored and transferred, led in the late 1960's to the creation of a new kind of communication. Computer networks and communications appeared for the first time as a Wide Area Network (W.A.N.) in 1969 with the creation of the Arpanet. Local Area Networks (L.A.N.) appeared during the early 1970's with Ethernet and the Token Ring protocols. Today computer communications are as important for telecommunication industry, as telephone or satellite communications are, and massive amounts of computer data are traveling around the world using telephone lines. Through the years many protocols have been developed, in an effort to harmonize incompatible systems and different data format, develop coding and signal levels, coordinate information and error handling and increase speed.

C. TRANSMISSION MEDIA

Besides Radio and Microwave transmission the most common types of transmission media are:

- Twisted Pair
- Coaxial Cable
- Optical Fiber

1. Twisted Pair

Twisted pair consists of two insulated copper wires arranged in a regular spiral pattern. It can be considered as an example of an "electrical conductor through which electromagnetic signals are passed" [CADWAL92]. It is one of the most common transmission media for both analog and digital data. The wires in a pair have a diameter from 0.016" to 0.036". Over long distances, cables may contain hundreds of pairs, each of them is separately twisted, in order to minimize electromagnetic interference between the pairs and data rates of 4 Mbps or more can be achieved. [STAL91]

2. Coaxial Cable

To succeed operation over a wider range of frequencies, coaxial cable is constructed by a single conducting wire, which is separated by a braided copper, concentric, conducting sheath [CADWAL92]. The two parts, which consist the inner and outer conductors are separated by dielectric material. The outer conductor is covered with a jacket or shield. Because its larger capacity, compared to twisted pair, coaxial cable has been used mainly for long distance transmission trunks, for both telephone and television. Using frequency-division multiplexing a coaxial cable can carry more than 10,000 voice channels. Today most of the existing coaxial cable networks are being replaced by optical fiber, microwave and satellite networks.

3. Optical Fiber

The development of optical fiber is the biggest revolution in the telecommunications industry of the 1970's and 80's. Its transmission capacity per cross-sectional area is about 100 times that of twisted pair and 10 times that of coaxial cable [MINOLI91]. An optical fiber is a thin (2 to 125 μm), flexible medium, made by various kinds of glasses or plastics, capable to conduct an optical ray. Its major advantages are the light weight, the small size, the low transmission losses and its large and high density bandwidth. Optical fiber is extensively used today on long-haul trunks, Metropolitan and Rural exchange trunks, Local loops and Local Area Networks (LAN) [STAL91].

D. INTERNATIONAL COOPERATION

1. The need for international standards

Telecommunications industry and government organizations worldwide have recognized that consensus standards and procedures, are needed to govern the physical, electrical, technical and procedural characteristics of telecommunications equipment, and facilitate the interconnection and interoperability of different carrier services.

In the past the lack of standards have led to confusion, while vendors were trying to monopolize the market, and users of different nonstandard equipment were obliged to

adjust their requirements to each manufacturer design. Today, standards are essential in the telecommunication industry, because they allow users to choose among a large collection of products, and permit products from multiple vendors to communicate and cooperate with each other. Standards lead also to Large Scale Integration (LSI), Very Large Scale Integration (VLSI) and mass production, that decrease prices and reduce the products cost.

Disadvantages in standardization process are that the development of a standard tends to freeze the technology, and that there might exist multiple standards for the same product [STAL91].

a. Types of Standards

There are two types of standards: Regulatory standards and Voluntary, Consensus standards. The first are imposed by international or national organizations for safety, health and environmental reasons [MINOLI91]. The second are imposed by users and providers in order to ensure common methods in doing business and make profit. Voluntary standards are divided into two categories: **de facto** and **de jure**. (Latin for **from the fact** and **by law** respectively) **De facto** standard is a standard that happened without any formal plan, it is often initially imposed by a single provider, usually a dominant vendor, and becomes accepted by the market. The development of the Ethernet is an example of a de facto

standard. Sometimes de facto standards lead to limited product sources, and to vendor dependencies. The elimination of such dependencies justifies also the need for international standards. **De jure** standard, on the other hand, is not a single provider product. It is a formal standard developed by some interested party or standardization body. A De jure standard represents a consensus product of the industry approved by the users. FDDI is a typical example of a De jure standard.

2. Standards Making Organizations

Advantages in technology, the growth in international trade, the proliferation of computers and distributed processing and the users demands have accelerated the evolution of international standards. Some 70% of the approximately 7,500 international standards now in practice, were created during the mid-1970s and early 1980s [MINOLI91]. The enormous variety in suppliers of services, make clear the need for compatibility on a worldwide scale.

International organizations for telecommunications, under the supervision of the United Nations, and different national associations, are working towards international standardization of current and future telecommunications technology. Effort is also made to help to improve telecommunications in underdeveloped countries. Some of these organizations are described below.

a. International Telecommunication Union

The International Telecommunication Union (ITU), which was founded in 1865, is the United Nations special department dealing with telecommunications. It is a union of about 168 member countries and its purpose is to harmonize the actions of nations towards the international cooperation and promotion of the development of telecommunications worldwide. It is consisted of five permanent organs : the International Telephone and Telegraph Consultative Committee (CCITT), interested in wireline communications; the International Radio Consultative Committee (CCIR), interested in radio and satellite communications; the ITU general secretariat, which sponsors the World Administrative Radio Conferences (WARC); the Bureau of Telecommunication Development, which provides technical support and helps to develop telecommunication systems and services in developing nations; and the International Frequency Registration Board (IFRB), which receives countries' proposals for radio frequency assignments.

b. International Telephone and Telegraph Consultative Committee

The charter of CCITT is "to study technical and operating questions relating to telegraphy and telephony." Its task is to provide functional and electrical recommendations for telecommunications and data communication, to achieve, regardless of the origin and destination country, end-to-end

telecommunications network compatibility and to provide interface services by standardizing the basic information transport functions.

CCITT has five classes of members. National Post, Telegraph and Telephone administrations (PTT) are class A members and the only ones with the right to vote. Private administrations, scientific, industrial and other international organizations belong to the other four classes.

CCITT is organized into 18 study groups. Each of them works on a specific topic such as telephone operations, data communication networks, telephone switching and signaling or digital networks. Each study group has three plenary meetings in a four year cycle. By the end of every cycle a plenary assembly is held where the work program for the next four years is established and the prepared standards, called Recommendations by CCITT are submitted. Different countries are not obliged to apply any CCITT decisions, but they are encouraged to follow them.

c. International Radio Consultative Committee

The purpose of CCIR is to study "technical and operating questions in radiocommunications and to issue recommendations." CCIR is also involved with issues concerning broadcast satellites and High Definition Television (HDTV). Its major concern is to generate the technical aspects for the use of the radio spectrum, regulate the use of frequency bands

and develop the performance criteria and system characteristics needed for compatible interworking. [MINOLI91]

ITU policy-making is conducted by periodically held administrative conferences, and CCIR is responsible for preparing the bases for the technical decisions to be made at WARC. The decisions made at a WARC correspond to an international treaty, and all the national representatives in the conference are obliged to present those agreements to their governments for approval.

d. International Standards Organization

The International Standards Organization (ISO) was founded in 1946 and is a nontreaty, voluntary organization consisting of the national standards bodies of 89 countries. ISO has published more than 5000 standards on a large variety of areas such as environment, agriculture, communication or minerals. It has more than 200 Technical Committees (TC), each responsible for a specific subject, and is divided into Subcommittees (SC) and Working Groups (WG). The ISO/IEC Joint Technical Committee 1 (JTC 1) is the most important TC relevant to telecommunications. It is a joint organization of the former ISO TC97 (dealing with computers and information processing) and the International Electrotechnical Commission (IEC) [MINOLI91]. One important area of standardization is the Open System Interconnection (OSI) communications architecture

and the standards at each of the seven layers of the OSI architecture.

In order for the ISO to adopt a standard, a national standards organization has to propose the formation of a WG in a specific area. This WG develops a Draft Proposal (DP) which is examined by the rest of the members for six months. In case of disagreement the DP has to submit several modifications before receiving the majority approval. A Draft International Standard document is then formed which is circulated for final comments and voting. Based on the results the official text of the International Standard is published.

e. Institute of Electrical and Electronics Engineers

The Institute of Electrical and Electronics Engineers (IEEE) is the world's largest professional society. In addition to publishing journals and running conferences, it develops standards related to electrical and electronic engineering, and computing. Its concerns include LANs, the interface of measurement instrumentation, and the first two layers of the OSI model, the Physical and the Data Link layers. The IEEE's 802 standard for local area networks is the basic standard for LANs.

f. International Electrotechnical Commission

The International Electrotechnical Commission (IEC) is concerned with electrical and electronic engineering standards and primarily with user protection from undesirable

side effects of radiation and electrical shock. In the area of information technology the IEC and the ISO formed the JTC 1 mentioned above, responsible for developing documents for "standardization in the field of information technology." Forty three countries are represented in IEC with more than 200 TCs, SCs, and WGs.

g. American National Standards Institute

The American National Standards Institute (ANSI) is concerned with functional and procedural standards, but it is not a standard making organization. It is a private, nonprofit association of standards making and standards using organizations, and represents the U.S.A. in the ISO and in the IEC. Its members are standards making organizations, private companies, customer groups, and government and regulatory bodies.

ANSI had published more than 8000 standards by the end of 1989, but does not develop them. Rather it approves standards developed by other organizations, and publishes requests for groups, to provide legal and financial support, and sponsor different secretariat (committees) for the development of a standard for a new product. IEEE for example which developed the IEEE 802 LAN standards is a member organization of ANSI.

The Exchange Carriers Standards Association (ECSA) is the sponsor of the ANSI secretariat for the T1 line, the

first telecommunication standard organization in the U.S.A. It was formed at the time of divestiture of AT&T, with the agreement of the Federal Communication Commission (FCC), to form the standards for the operation of the telephone system in the U.S.A. T1 provides interconnection standards for the national telecommunications system but also is concerned with international matters by providing proposals to the U.S. Department of State. It has six subcommittees each of them is divided in smaller working groups. T1E1 is concerned with carrier-to-customer installations, T1M1 is concerned with internetwork operations, maintenance and administration, T1Q1 deals with performance matters, T1S1 covers services architecture and signaling, T1X1 is concerned with digital hierarchy and synchronization, and T1Y1 with specialized subjects. [MINOLI91]

h. National Institute of Standards and Technology

The National Institute of Standards and Technology (NIST) is a part of the Department of Commerce (the National Bureau of Standards until 1988) and it is responsible for the computer systems technology. It publishes Federal Information Processing Standards (FIPS), compatible with the international standards, for equipment sold to the federal government.

i. European Standards Organizations

The European Conference of Postal and Telecommunications Administrations (CEPT) was formed in 1959.

Its 26 members include most European countries, including former Yugoslavia, but for the moment not the countries of Eastern Europe. Its purpose is to improve postal and telecommunication cooperation among European Countries, in order to succeed consistent and efficient communication in the area, and promote the development of telecommunications in Europe. It is divided into the Post and the Telecommunication committees. Each committee consists of study groups, often working in parallel with those of CCITT, interested in terminal equipment signaling, protocols and signaling, networks aspects and Integrated Services Digital Network (ISDN). In 1988 CEPT created the European Telecommunications Standards Institute (ETSI) which represents the 12 European Community (EC) countries. ETSI is replacing CEPT as the regional standards body and is currently responsible for the technical standards-writing activities of CEPT. [MINOLI91]

III. CURRENT WORLD TELECOMMUNICATIONS

A. REGIONAL PROFILES

Because of the large technological differences between the different countries in the world, there is a wide variation among the telecommunication equipment and services markets around the world. ITU groups nations into nine separate telecommunications zones. Discussion will be made for each of the zones and the current status of telecommunications therein, with details about current telecommunications industry and future trends in the three big telecommunications markets: the United States of America (U.S.A.), Japan, and the European Community. The nine zones are the following:

- North America - **Zone I**: Canada, the United States, Puerto Rico, Dominican Republic, Grenada, Jamaica and nearby islands.
- Africa - **Zone II**: The African nations.
- Western Europe - **Zone III**: European Community and the rest of the European countries except former Soviet Union and Eastern Europe bloc countries.
- Eastern Europe, former U.S.S.R. - **Zones IV and VII**: Albania, Bulgaria, Czechoslovakia, Hungary, Poland, Rumania, Russia and former Yugoslavia.
- South and Central America - **Zone V**: All countries between the southern border of U.S.A. to the Tierra del Fuego near the Antarctic.
- South Pacific - **Zone VI**: Australia, New Zealand, Singapore, Thailand, Malaysia, Indonesia, Papua, New Guinea, Philippines, Guam, and surrounding island nations.

- Far East - **Zone VIII**: China, North and South Korea, Laos, Vietnam, Bangladesh, Taiwan, Hong Kong, Japan and surrounding countries.

- Middle East and Southeast Asia - **Zone IX**: Saudi Arabia, Jordan, Kuwait, Syria, Iraq and other Arab nations, India, Pakistan, Afghanistan, Burma, Nepal, Turkey, Iran and Israel.

Table II. shows the distribution of telephone main lines among the different geographical areas described above.

Table II WORLD'S DISTRIBUTION OF TELEPHONE MAIN LINES BY GEOGRAPHIC AREA

Geographical Area	World Main Lines %	Main Lines/ 100 population
Europe	40.12	20.93
Africa	1.22	0.91
North/Central Amer.	28.08	28.60
Asia	25.33	3.34
South America	3.33	5.02
Oceania	1.88	29.63

Source : ITU

1. North America - Zone I

The North American region, mainly U.S.A. and Canada, represents the largest share, almost one third, of the world's telecommunications market. In both countries, specially in U.S.A. the market is largely deregulated and the region is fiercely competitive.

U.S.A., presented with more details in Chapter IV, possesses the largest telecommunications industry in the

world. Marketplace competition, and economic freedom, have been the key principles for the U.S. telecommunications development and the many benefits in the provision of Customer Premises Equipment (CPE) and long distance telephone services. The most impressive characteristic of U.S. telecommunications market is not the more than U.S. $90 billions of operating revenues, or the 93.3% of households with telephones. More impressive than these large numbers is the policy followed by the leaders of that market.

> Competition in an open marketplace is the best guarantor of quality, diversity, and affordability. Where competition is not feasible, regulators should provide incentives that simulate the effects of competitive conditions to the maximum extent feasible. In most cases, reliance on the marketplace or effective market surrogates will achieve far more than top-down decisionmaking by even the most enlightened government officials. [NTIA91]

Similar to its powerful neighbor, Canada's telecommunications policy is moving to a deregulated and competitive market, but on a more cautious pace. With 98.2% market penetration, Canada has one of the highest usage rates in the world.

The Canadian telecommunications environment, with a large geographical area and many remote communities, does not easily adapt to competitive and open markets. Large telephone companies, members of Telecom Canada, retain a monopoly over basic local and long distance telephone services. Regional independent telephone companies provide local and long distance services to limited geographical regions across the

country. Competition has been allowed in terminal attachment and private line services. [CONTEC89]

U.S.A. and Canada both working to establish compatible telecommunications standards in technical specifications, regulations that apply to productions methods and technical equipment like Central Office (CO) switching, Private Branch Exchanges (PBX), electronic key telephone systems and modems. On January 1988 both countries signed a free trade agreement to remove different tariffs and trade barriers existed between them. [CONTEC89]

2. Africa - Zone II

Africa, the second largest continent on earth, with a population of over 500 million, has the lowest telephone density in the world. According to the Africa telecommunications statistics of ITU, in 1988 the digital exchange lines density was 0.76 per 100 inhabitants, the telephone density was 1.11 and the telex lines in total were 64,443. In addition to the problem of limited availability, there is also a great disparity in telecommunications development within the continent. South Africa alone accounts for 43% of all telephone installations, and in the rest of the continent the vast majority of telephones are located in the main cities, while there is little service to rural areas. In 1988 there were 6.353 million telephone units in Africa, 83% of which were located in urban areas (inhabited by 68% of the

population). Despite the inadequate infrastructure, manifold social and geographical problems and shortages of funds, most African states recognize that a strong telecommunications sector is a main element for the economic development of any country, and take measures to improve their communications networks.

In 1968 the ITU and the African Administrations founded a project for the Pan-African Telecommunications network (PANAFTEL) to link all African countries through a modern, high quality telecommunications system. The PANAFTEL project was expanded after 1972 to about 43,000 transmission lines installed with more progress in the Western, Northern and Southern African nations. Today a 20,000 kilometer transcontinental network, which is based on both terrestrial and satellite links, allows member states to communicate with each other and the rest of the world. Another project for the development of satellite and terrestrial networks, founded in 1987 by ITU, is the Regional African Satellite Communications System (RASCOM). The purpose of this project is to determine the appropriate mixture of space and terrestrial technology required to meet the anticipated needs of Africa through to the early part of the next century. [CONTEC89]

The Economic Community of West African States (ECOWAS), a 16 nation regional cooperative, is also working for the improvement of the telecommunications infrastructure. ECOWAS obtains loans from multi-lateral sources,(example is a

U.S. $26 million loan provided by the European Investment Bank in 1988 for the installation of exchanges and other related equipment), supervises community telecommunications projects and provides loans to individual countries, and some of the capital needed to built and modernize the telecommunications infrastructure. Many African countries allocate 2% to 5% of development budgets for telecommunications. Due to enormous economical and technological limitations these states still demand financial aid from developed countries to maintain and improve their existing networks and provide new services. The main financial sources for telecommunications projects in Africa are the World Bank and the African Development Bank. The capital provided by those banks mainly goes to private European communications companies. Because Africa lacks indigenous telecommunications industry, and African countries must rely on foreign suppliers for equipment, so these companies dominate the telecommunications market in the area. At the present time a broad range of telecommunications technology is installed. This technology includes satellite earth stations, mobile radio and microwave transmission systems, as well as exchange equipment, much of which is based on older analog technology. PANAFTEL latest recommendation was that each member state upgrade their switching and transmission equipment with modern digital microwave equipment and fiber optic transmission cables. [CONTEC89]

a. Government Policies and Regulations

Telecommunications services in Africa are mainly provided by government monopolies. Some countries have separated their domestic and international operations but still postal and telecommunications activities are mainly controlled by national PTTs. Because of the nature of telecommunications, which is a dynamic growth sector, an increasing pressure has been applied to many administrative agencies to move towards liberalization and privatization and some positive changes have already been made. The Kenyan President took aggressive steps to terminate the monopoly of the Kenya Posts and Telecommunications Corporation, by allowing local competition in that service sector. In 1990, the "Office Centrafricain des Postes et Telecommunications" of the Central African republic along with the French company France-Cable et Radio, formed a new private communications company, Socatel. [CORKRAN91]

> African countries are taking many significant steps to expand their telecommunications networks. In developing future networks and services they will continue to face the challenges arising from a hostile physical environment, ongoing financial constraints, and large numbers of remote communities. Foreign vendors, particularly those from European countries, with whom African countries have old colonial links, will continue to dominate their equipment markets [CONTEC89].

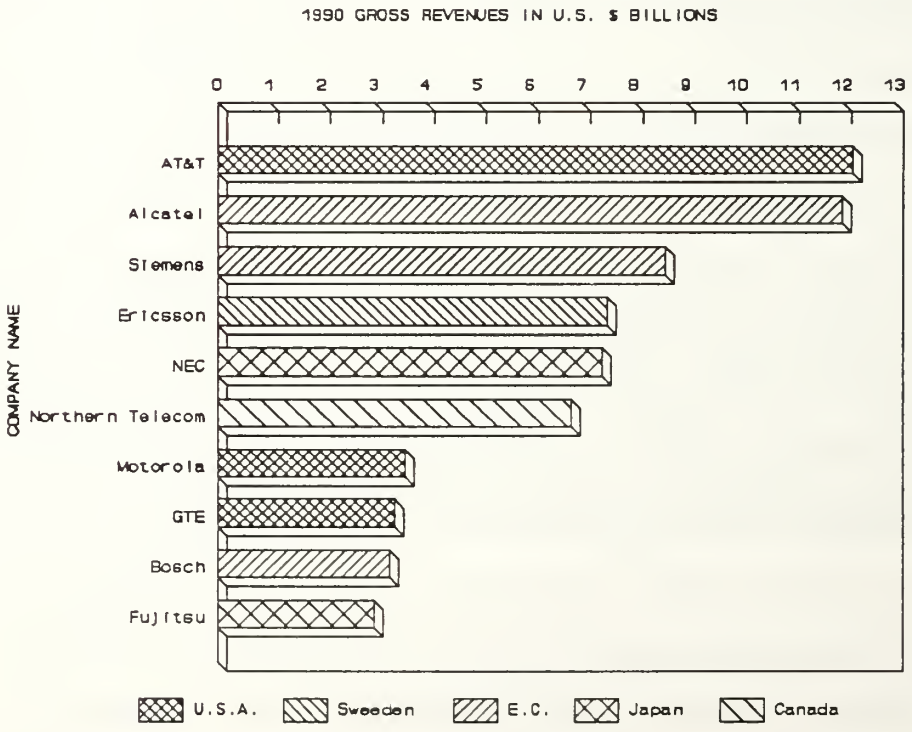
Along with the major colonial powers, United Kingdom and France, the United States, Japan and Germany are now entering the African telecommunications market. Today African telecommunications are rapidly expanding and

modernizing and problems like state ownership of Telecommunications and Posts and lack of foreign exchange and liquidity are becoming less severe.

3. Western Europe - Zone III

The telecommunications market in western Europe, including Austria, Finland, Norway, Sweden and Switzerland, the European Free Trade Area (EFTA) countries, represents one of the largest markets in the world. With a market of over 350 million people telecommunications industry in western Europe is also one of the most profitable. Table III shows the world's top 10 telecommuncations services companies.

Table III WORLD'S TOP 10 TELECOMMUNICATIONS SERVICES COMPANIES (64% OF THE MARKET)



According to that table, the European Community and Swedish telecommunications services companies together reported earnings for 1990 U.S. $31.4 billions, when U.S. companies reported U.S.$18.2 billions and Japanese only U.S.$10.4 billions. [BELL]

The two major characteristics of the European market are the big fragmentation, the regulatory environment and the government monopoly, in most of the different European countries PTTs. Public monopolies were thought necessary to maintain international standards, to cover the high cost of telephone networks and to maintain national security.

Today that telecommunications industry has moved far beyond the simple telephone and telex communications, the new forms of telecommunications, which are less easily defined and regulated, opened new market opportunities and obliged governments to allow greater competition in the marketplace.

The main force behind this liberalization policy is European Community, which has been pushing its member states to open their telecommunications markets since 1970's. Commission's Green Paper, issued in 1987, proposes that national PTTs should retain control only over the basic voice telephone network and they should allow free competition in enhanced services and equipment markets. [CONTEC89]

Responding to the technology challenges and to the pressures of international competition, all western European countries have taken measures towards the modernization of

their networks. Many companies have chosen joint ventures, consortia and mergers with other national, European and overseas partners, in order to gain shares of the growing international market and remain internationally competitive. More important, following the EC's example, step-by-step Europe is moving towards a less regulated and more competitive telecommunications market and many non-European carriers can compete for their share in the European market. Recently U.S. Sprint announced its intention to become the third major carrier in U.K. in 1992 by building in South England a 800 to 1,000 miles fiber cable network to support both domestic and international private-line services [CROCKETT92]. UPS Telecom is also interested in providing international private line service to Germany and U.K.

Sir Leon Brittan, EC's Commission vice-president in charge of competition policy, recently said that in 1992 EC will evaluate whether to allow carriers in the common market to maintain monopolies over the public switched telephone services. The German minister of posts and telecommunications said that DBP Telekom needs to be transformed to a private company to compete in the rapidly changing global network market. A recent EC study showed that users in continental Europe pay three to four times more for calls between European cities, than users in U.S.A. for similar distance domestic calls. [NETWORLD2]

a. United Kingdom

United Kingdom is the only European country with a highly competitive and private telecommunications services and equipment industry. In the 1980's the British government sold 51% of British Telecom (BT) to private investors and in 1984 the Telecommunications Act opened competition, by allowing Mercury Communications to compete with BT on the national public network. In March 1991 the British government opened telecommunications market to full competition.

BT, which reported U.S. $5.7 billion profit for 1990-91, considering its massive capital investment in the existing copper local loop, has currently adopted a narrowband services entry strategy to replace copper with fiber. In March 1990 the digitization of the trunk network was completed with 398,000 fiber km as the dominant transmission media. 493,000 fiber km link trunk exchanges, to over 7,000 local exchanges. Over 86% of subscribers are connected to the network, but only 72,000 fiber km have been installed in the local network, since under the current regulatory environment and cost, Fiber To The Home (FTTH) is not viewed yet as a realistic solution. [ROWB91]

b. Germany

On July 1, 1989, the German Deutsche Bundespost (DBP), following the Green Paper's directives, separated its functions into three public enterprises, DBP Telekom, DBP's

Postal service and DBP's Postal bank. DBP Telekom still possess the monopoly in installing and operating all transmission paths and telephone services. The rest of the services, text, data, value-added, mobile and terrestrial services, are provided along with other private enterprises. Today DBP Telekom represents one of the world's four largest telecommunications operators with a revenue of more than DM 40 billion in 1990.

DBP Telekom's major areas of activity are the continuing installation of digital switching and transmission equipment in the telephone network, the profitable use of optical fiber for replacement and possible use of an fiber network for individual broadband communication, and the absorption and equal development of East Germany's telecommunications infrastructure within seven to ten years. The predictions are that long term projects like the extension of a new fiber cable network, through the use of the Fiber In The Loop (FITL), as far as the subscribers homes will be completed in 20 to 30 years period. [TENZER91]

For 1991 Germany led the European countries in the fiber optics market with a market size larger than U.S. $240 millions. DBP Telekom and BT came recently into an agreement to establish a common policy of local loop requirements, in order to produce common specifications and lower the prices of key fiber network components. [KOLOD91]

c. France

Similar to Germany, France Telecom, is currently a state-owned monopoly. France PTT is France's sixth largest company, but its top tax payer, with more than U.S. $2.4 billions paid tax for 1991. The French socialist government believes that the big industrial risks and the vast investments needed to be done in a large industry such as telecommunications, can be afforded only by the state. Despite EC's policy the status of France Telecom will remain the same at least until 1994. [ECON91]

In the mid-1980's in Biarritz, France took place one of the most famous FTTH experiment, where some 1500 subscribers were connected in a switched star, multimode fiber network. Multiple television channels and video-telephony were the more important offered services. Mainly because of the expense of construction and subscription, the low quality programming and the poor marketing, the implementation of a fiber-based interactive services fell behind. [WILL90]

In 1991 France Telecom started a project of a fiber-optic network to support France's nationwide telecommunications network. The French Alcatel-CIT and S.A.T. will provide equipment meeting synchronous digital hierarchy transmission standard. Currently the French network, mainly for security reasons, consists of two separate sub-networks. The two networks interconnect 50 cable and 50 microwave nodes, located at the same premises as long-distance transit

exchanges. With the completion of the first stage, by the end of 1992, 74% of subscriber lines will be connected with Paris through optical fiber. The French PTT announced that the project will be completed in 1995 and the new technology will be able to support transmission speeds up to 2.5 Gbps and it will protect a large part of the existing network configuration. [BOULT91]

4. Eastern Europe - Zones IV and VII

The dramatic changes that started with Mikhail Gorbachev's Perestroika (restructuring) in the 1980's, followed by 1989's revolution in Eastern Europe, led to the dismanteling of the Soviet Union and Eastern bloc. After the restoration of democracy, the first political euphoria and optimism were replaced by the pessimism triggered by the economic situation left by the Soviets. The 1990's is the decade of reality, the time to leave seventy years of Communist rule and move towards a free enterprise system and competitive economy.

Eastern Europe has only 20% of the European telephone base, and telephone density is much lower than in Western Europe. For example Bulgaria has 1 telephone per 100 population, Poland 7 and Hungary and Romania 10. Between 10 and 15% of the telephones were in the former Soviet Union and Poland and 20 - 25% in the former East Germany and

Czechoslovakia. In every eastern bloc country there is an 8 to 10 years waiting list for basic telephone service.

Before 1980 the Council for Mutual Economic Assistance (COMECON) had developed trade treaties among the member countries, rather than with the rest of the world. In addition any International trade had also to obtain the approval from COCOM council. COCOM is a western security organization, which deals with trade issues with the Eastern Europe countries. Its major objective was to prevent the leakage of strategic high technology, products and services towards Eastern bloc countries. With the success of Perestoika, the need of a large scale introduction and upgrading of computing and telecommunications facilities to restore the economy, became obvious. COMECON agreed to a program for the joint development of ISDN, the introduction of fiber-optic and satellite communications. After the introduction of Glasnost (openness) in the former Soviet Union, COCOM's policy slowly began to change, showing signs of loosening the restrictions on high technology products to Eastern Europe. [CONTEC89]

While COCOM policy still represents an obstacle, the many years ofgovernment monopoly through the national PTTs, which only recently began to change, has developed an isolated market, with few bases to support imported western technology.

In the U.S Department of Commerce report on telecommunications in Eastern Europe, the situation is described as "among the poorest and most antiquated in the

world." In every country, according to the report, the need for information about management, technology accounting and investment in a free market economy, is more urgent than foreign economic aid. In Poland, Solidarity leader Stefan Bratkowski said that:

> Poland and the other Soviet bloc countries only need an intellectual Marshall Plan that is much cheaper and much more effective than any material help lecturers, consultants, advisors, translated manuals and popular books, videotapes with lessons on banking or accountancy. [NTIS90]

a. General Perception

In the telecommunications sector, the service provided by the telephone network reaches 5% of households in rural areas and 25% the big cities. The telephone system is characterized as **extremely out-of-date**, with equipment 40 - 50 years old. In Czechoslovakia recently were found 700,000 subscriber lines installed by Siemens in the 1920's [ECON91]. Digital switching and cellular mobile telephone do not exist. The basic network in every country is profitable but for a long time it has been the subject of artificial taxing policies. The soft currency of those countries is a major factor limiting non-domestic sources of hardware and technology and makes near-term repartition of profits extremely difficult. [NTIS90]

In the manufacturing sector, telecommunications equipment industry faces serious problems of overstaffing, inefficient use of resources and old technology. Until

recently communications services were representing a lower priority services. This perception, along with the restrictions imposed by COCOM and the policy to limit foreign suppliers among the Eastern bloc countries are the major factors for that backwardness. Every country is considering today the possibility to create joint ventures with western companies in order to acquire new technology and other markets among neighboring countries. Different policy makers in the governments are moving towards new regulations for investment, ownership and repatriation of earnings to attract foreign capital. [NTIS90]

After 1990 the developments in Soviet Union and Eastern Europe led to the opening of those markets to western companies and investments. Basic problems of the telecommunications market in Eastern Europe are the antiquated telephone and broadcast systems, the lack of understanding of business in a market economy, and the old technology that needs major changes to become competitive. But after the successful political reforms, the burning desire to modernize, the strong market demand, the trend towards privatization and liberalization and the essentially profitable, already existing, networks, provide a strong base for the growth of the telecommunications market, strongly necessary for an economic growth.

In eastern Europe a modern telephone network can be seen as a ticket to the 21st century.

If they can get one before the end of 1990's, they have a chance of sharing in the future progress of telecoms technology. If they cannot, they risk being behind for ever divided from the developed world by an electronic gap that will grow every decade. [ECON91]

5. South and Central America - Zone V

The region of South and Central America covers the area, from the southern border of the United States to the Tierra del Fuego near the Antarctic. Spanish, Portuguese, domestic cultures and historical development of the Latin American countries encouraged the development of regional incentives to improve telecommunications networks and services. The Inter-american Telecommunication Conference, which was established in Latin America, fosters interregional cooperation in developing telecommunication technologies and telecommunications industry is experiencing dynamic growth. Computerized telephone services, satellite links for domestic and international traffic and fiber optic facilities are being installed in many countries. [CONTEC89]

Over 80% of telecommunications revenues in Latin America are generated through telephone services. The amount spent on telecommunications services varies with each country, from a high of $74 per person in French Guyana to $0.83 per person in Chile. Most of the recent modernization has been focussed on urban areas, leaving many rural areas and remote locations underdeveloped. Satellite and radio based transmission technology is likely to play a significant role

in the establishment of new communication services to these rural areas.

Most of the organizations providing telecommunication services are either government owned or government controlled PTTs. Telecommunication equipment industry consists of foreign suppliers, local manufacturing firms and the local affiliates of international companies. Local manufacturers are usually protected from foreign competitors. Restrictions on foreign suppliers usually exist when foreign companies are competing against domestic suppliers.

The telecommunications market in the area is still under development. To continue development governments should adopt more liberal and less regulated policies and support the development of new technologies. TELEBRAS, Brazil's PTT, works closely with private industry and universities to increase country's self-sufficiency in telecommunications technology. Some countries consider privatization strategies in order to overcome financial difficulties and problems in meeting new user demands. In Argentina, the government is discussing selling 40% of ENTEL, Argentina's PTT, to Telefonica of Spain. It has also eliminated ENTEL's monopoly by allowing PRIVATEL, a private company, to provide telephone services such as cellular radio, videotext, television networks and date communications facilities.

Since 1987, Mexico has made significant progress. Until few years ago, telecommunications in Mexico were highly

undeveloped, a subject of big government taxation policy and a privilege of the few wealthy citizens. Even in Mexico City, only 25% of the subscribers had private lines. Businesses relying on telecommunications usually had to resort to private networks, not always available. Reforms in telecommunications were a national priority by mid-1980's, but the country's economy wasn't strong enough to support the necessary drastic changes. By recognizing the need for privatization, with a set of radical measures on December 1990, Telmex's, Mexico's PTT, shares were offered to Mexican investors and also to France Telecom and one of the Regional Bell Operating Companies (RBOC), Southwest Bell. Under the agreement, Telmex will be protected from full competition until 1997, and will have to pay only normal taxes. In return, it must invest about U.S. $10 billion to double the number of lines in Mexico and over the next six years the company must meet a detailed set of performance criteria. The predictions are that by 1997 Telmex will be strong enough to face open competition and by 2005 the current electro-technical systems will be replaced by a fully digitized network. [ECON91]

6. South Pacific - Zone VI

The South Pacific region is one of the fastest growing telecommunications market in the world. Telephone penetration in this region ranges from a high of 71.3% in New Zealand into 0.72% in Indonesia. Telecommunications infrastructures and

regulatory environments also vary from country to country. Telecommunication services in Singapore and Indonesia are completely state-controlled. In the Philippines, they are provided by a combination of private companies and government agencies. Finally, New Zealand is one of the few countries in the world, with a fully competitive telecommunications market. The geographical dispersion of many of those countries and the large number of remote areas, led to the adoption of submarine cable and satellite technology to improve communication networks.

A growing network of submarine cables now complement the Indosat, Aussat, and Papua satellite systems which provide satellite based communications in the region. [CONTEC89]

The lack of domestic manufacturing facilities, makes the region a prime market for major world telecommunications manufacturers. The opportunities that exist for foreign suppliers depend on establishing manufacturing agreements and joint ventures. Japanese and European vendors dominate the highly competitive South Pacific markets. Ericsson of Sweden and NEC of Japan are the leading central switching suppliers, while Ericsson also dominates the cellular telephone market. Siemens of West Germany has also been involved in many projects. To improve the opportunities of U.S. manufacturers, the United States has taken various actions in the form of trade delegations and financial incentives. In the

Philippines, U.S. companies were supported by the long U.S.A. military presence. [CONTEC89]

In many countries, activity has focussed on improving communications to rural areas which are currently undeveloped. In the Philippines, for example, 80% of the telephones are in Manila, while eight cities and thirteen provinces are without any telephone systems. Other countries, such as Australia, New Zealand and Singapore are currently installing new digital technology and high capacity fiber optic systems, in order to provide voice and data services to the market and to prepare for ISDN. Indonesia, which already invested U.S. $400 million for the digitization of its network, is planing to spend another $700 million during the 1990's. [CONTEC89]

The new digital telecommunications technology and the growth of the market, the need to maintain and improve the existed networks, is putting more pressures on national PTTs. In order to become and remain competitive, governments have to reestablish their objectives, and determine and implement new national communication priorities.

In Australia, the government changed its state-owned policy and allowed the private sector to move into the market. On 1991, international firms were invited to compete for the license of a new carrier, in addition to the domestic PTT, Telecom Australia. The U.S.A. MCI announced, early 1991, the formation of a joint venture with the Australian Associated Press Group. Plans have been made for the unification of

Telecom Australia and the smaller international carrier Overseas Telecommunications Corporation (OTC), aiming to a completely free market in 1997. [ECON91]

7. Far East - Zone VIII

This area is characterized by the enormous variation of the economical and technological level of each country. In consequence telecommunications industry also varies from almost undeveloped and regulated China or Bangladesh to highly developed and deregulated Japan. Telecommunications in most of the countries of the area are highly regulated and they are mostly characterized by government monopoly.

Government control exist in China, where the Ministry of Posts and Telecommunications has complete responsibility for regulating and developing telecommunications. In Hong Kong, telephone services are provided by the Hong Kong Telephone Company, a public company which operates under government regulation. In Macao basic telephone services are provided by a private company, CTM, owned by the U.S.A. Cable & Wireless. [CONTEC89]

The telecommunications networks in the poorer countries of this region consist primarily of telephone lines and are significantly underdeveloped. Telephone density in Bangladesh, for example, a country with a population of over 115 million is 0.2 for every 100 inhabitants. In Sri Lanka there are 0.8 telephones per 100 people and in China 1. In

contrast the same ratio in Japan is 48.2% and in Hong Kong 44.7%. [APT1]

The more economically advanced and growing countries in this region are investing heavily to improve their telecommunications infrastructures. In 1984 China announced a U.S. $40 billion expansion program, to increase the number of telephone lines to 33 million by the year 2000. The country is also building two satellite earth stations: one in the city of Shanya and the other on Yongxing island. [CONTEC89]

In 1991, Korea announced its intention to transform the Korea Telecommunication Authority (KTA) from a public enterprise to a non-government business enterprise, under the name Korea Telecom. The new company is expected to grow to be one of the world's blue-chip companies, and by the year 2000 to acquire the technology capabilities at the level of the Group of Seven [APT1]. An investment program, valued at U.S. $6.5 billion, is currently in progress, to install one million lines annually through the year 2000 [CONTEC89]. Korean carriers, KTA and Data Communications of Korea are members of a plan, that by the end of 1993 will interconnect carriers from Australia, Japan, Hong Kong, Korea and Singapore.

The existence of programs like these indicates that many of these markets have been open to foreign technology imports. The U.S. Cable and Wireless, AT&T, and Northern Telecom and the European L.M. Ericsson, are major technology providers of those markets. Imports of telecommunications

equipment into this region total between U.S. $3.3 million and $1 billion annually. Many countries in this region, however, are also heavy exporters of telecommunications services. Companies based in the Far East have acquired substantial market shares in their domestic markets as well as the markets of other Asian countries. [CONTEC89]

With the organization of seminars and joint projects, efforts are made to improve the know how and telecommunications technology in the region. The Japanese Ministry of Posts and Telecommunications with the participation of many nations in that area organized the International Seminar on Optical fiber Submarine Cable Systems in 1990. In 1991, with the cooperation of the Asia-Pacific Telecommunity (APT), the Tokyo Forum '91 on Asia-Pacific Mobile Communications Development. [WHITEPAPER91] In 1990, Hong Kong Telecom International Ltd., along with U.S. Sprint and the U.K. Mercury Communications, developed the first and only fully integrated international software defined network. The Global Virtual Private Network (GVPN), demonstrated in U.S. in May 1990, can handle

> combinations of voice, data, image and video, with the inherent economy and reliability of the switched network. [APT1]

A modern telecommunication network with ISDN, optical fiber networks, international Value-Added-Networks (VAN), and mobile communication, will play an extremely important role in the social and economic development of these regions. As more

countries in the area continue to develop their industries, to compete with foreign suppliers, telecommunications market will become more competitive and profitable.

8. Middle East and Southeast Asia - Zone IX

The nations included in the geographical area which makes up the Middle East and Southeast Asia ITU Zone represent a wide variety of languages and cultures. Telecommunications services and regulatory environments vary widely from country to country. Countries in the western area of the zone have developed telecommunications infrastructures, but those in the eastern part make efforts to modernize their basic telephone networks. For example in Afghanistan the telephone rate is 0.2 for every 100 inhabitants, in India 0.59% and in Pakistan 1.11% [APT1]. In most states government organizations or government controlled PTTs maintain either direct or indirect control over telecommunications services.

In some situations telecommunications services are provided by separate companies under some government ownership or regulation (ex. Saudi Arabia). In other cases, like Bahrain, private companies along with the government share responsibility for telecommunications through specific joint ventures. Israel is the only example of private management and control. Since 1982, a private company, Bezeq, has been running Israel's telecommunications services. [CONTEC89]

A few years ago, regional communications organizations were formed to improve and develop telecommunications networks in the area. In 1976 the Arab Satellite Communications Organization (ASCO), a specialized agency of the League of Arab States, was founded. Its members are the Arab countries of the area but also countries from Africa. Regional projects, guided by those organizations, are the MedArabtel microwave system which includes a 250 km link and 26 stations across the Red Sea, and a 1000 km fiber optic link between Syria and Jordan and a 520 km submarine cable link between Bahrain, Kuwait and Saudi Arabia. India, which is a member of the Asia Pacific Telecommunity (APT), established in May 1979, is a country with substantial funds, and is currently developing digital public switches and other communication technologies to improve its national network.

Because of the topography of many remote areas of that Zone, as well of Zones VII and VIII, satellite, microwave and cellular technologies are very important for the future development of telecommunications networks. International organizations like INTELSAT or ARABSAT are already working on projects and currently provide satellite telecommunications links throughout the area.

IV. TELECOMMUNICATIONS IN THE 1990's AND THE 21st CENTURY

A. INTERNATIONAL COMPETITION

Since 1876, when Elisha Gray and Alexander Graham Bell were competing to invent and operate the first telephone, until the threshold of the 21st century, the enormous advance of telecommunication industry has changed at large the background of the social and economic realities in our society and the quality of peoples life. The need for accurate, fast and update information in today's society, the developments in information and communication industry, the continuous evolution of computer speed, power and capacity, and the rapid diffusion of computers in every business, for the last twenty years, have changed the way people live, work and think.

Strong telecommunications infrastructure can increase the economic development and improve the quality of life of the nations by providing information, health, education and entertainment services.

The telephone penetration rates for 1989 in the countries of the Organization for Economic Cooperation and Development and average annual Public Telecommunications investment from 1980 to 1989 appears in Table IV.

Table IV WORLD'S TELEPHONE PENETRATION RATES AND INVESTMENT

COUNTRY	TELECOM * INVESTMENT	INVESTMENT IN MODERNIZATION	LINES/100 POPULATION**	RANK
Sweden	9,364	85.6 %	66.7	1
Denmark	4,184	77.7 %	55.1	2
Switzerland	11,185	87.3 %	54.1	3
Canada	28,244	79.1 %	53.4	4
Iceland	119	53.2 %	51.1	5
Finland	5,181	75.6 %	49.9	6
Unit. States	217,509	86.6 %	49.0	7
Norway	5,778	77.3 %	47.8	8
Australia	16,964	74.8 %	46.6	9
Germany	76,057	84.5 %	46.3	10
France	51,002	67.5 %	45.2	11
Netherlands	7,276	62.9 %	43.7	12
New Zealand	1,742	70.0 %	43.2	13
Luxembourg	236	72.1 %	42.6	14
Japan	107,251	84.1 %	42.2	15
Un Kingdom	33,586	65.8 %	41.4	16
Belgium	5,603	65.6 %	40.1	17
Austria	8,090	83.1 %	40.0	18
Greece	2,953	23.0 %	36.2	19
Italy	46,785	73.5 %	34.9	20
Singapore	1,278	46.2 %	34.6	21
Spain	22,314	69.3 %	28.1	22
Ireland	2,693	76.6 %	22.5	23
Portugal	2,947	46.8 %	17.8	24

* Values in US $ Millions ** OECD countries plus Singapore
SOURCE : NTIA Telecommunications in the Age of Information

The **chicken and egg** problem about who was first created and who is the ancestor of the other, and the analogy to the relationship between Telecommunication and economic development presented in [NTIA91], perfectly describes today's need for telecommunication development.

For the last three decades of the 20th century U.S.A., Japan and European Community (the three big telecommunication markets) were dominating, and will lead at least into the beginning of the next century, the information and communication industry. The main common characteristic of those markets is the free economy and the open and competitive market. Government policy in those countries promote competition and deregulation, by relying on market forces, providing incentives to develop competitive environment, and at the same time make necessary adjustments to avoid monopolies that decelerate evolution.

1. Technological Trends in Telecommunications

Since the development of telegraph and telephone, the increased competition between the three big telecommunications markets and among the various service and equipments industries, and sometimes the competitive government policies which trigger the international competition, are accelerating the speed of the technical evolution and deployment. New technologies, like fiber optic transmission media and digital signals transmission and switching, will join in the near

future the current telecommunications networks, by improving the basic network services in offering basic voice, data, video, and information services. [NTIA91]

In Table V. we can see the investments recently made by the nations with the highest Gross National Products (GNP), also called the "Group of Seven."

Table V PUBLIC TELECOM. INVESTMENT IN THE GROUP OF SEVEN. COMPARATIVE PERCENTAGES DEVOTED TO NETWORK MODERNIZATION FOR 1980-89

COUNTRY	I N V E S T M E N T				
	TOTAL**	MAIN LINES	EXPANSION	MODERNIZATION/RANK	
U.S.A.	192,058	16,181	% 12.6	% 87.4	1
Japan	90,560	10,012	% 16.6	% 83.4	2
Germany	67,763	7,544	% 16.7	% 83.3	3
Canada	20,236	3,301	% 24.5	% 75.5	4
Italy	38,052	7,075	% 27.9	% 72.1	5
France	46,648	9,929	% 31.9	% 68.1	6
U.Kingdom	25,932	6,715	% 38.8	% 61.2	7

* Capital investment by public telecom operators excluding land and buildings. Unadjusted for differing treatments for labor costs and CPE inclusion ** Values in US $ Millions
SOURCE : NTIA Telecommunications in the Age of Information

a. Optical Fiber

The development of Fiber Optic communication systems has been one of the most significant technological breakthroughs in data transmission of the last decade. An optical fiber is a thin flexible medium, in a cylindrical shape, capable of conducting an optical ray. Fiber optic transmission systems include light sources, optical fiber

strands, and light detectors. The transmission distance of a lightwave can be increased with the use of regenerative repeaters. Table VI. shows the public network optical fiber density ratio, measured as kilometers of fiber per thousand square kilometers of territory, in the group of seven.

Table VI PUBLIC NETWORK OPTICAL FIBER DENSITY RATIOS FOR THE GROUP OF SEVEN

COUNTRY	1988 RATIOS	1989 RATIOS	RANK
France	NA	161.80	1
Unit. Kingdom	100.82	NA	2
Germany	45.56	75.43	3
Japan	55.89	NA	4
Unit States	26.25	34.47	5
Canada	4.52	7.33	6
Italy	NA	NA	NA

SOURCE : NTIA Telecommunications in the Age of Information

The advantages that optical fiber offers compared with twisted pair and coaxial cable are the greater bandwidth (data rates of 2 Gbps over tens of kilometers), smaller size and the lighter weight, lower attenuation, and much greater repeating spacing. [STAL91]

Disadvantages of fiber are the current relatively high cost and that it is harder to splice than copper media. Because of its declining costs and the extremely high capacity, fiber optic transmission facilities today are increasingly used in public and private networks, replacing copper and radio transmission systems.

b. Integrated Services Digital Network

The international competition towards lower cost and better quality of voice transmission and networking services are accelerating the use of digital technology in the telephone and telecommunications networks. The revolutionary idea of 1959 that digital Switching and Transmission could be integrated to form an Integrated Digital Network (IDN) is currently being implemented worldwide. The network called Integrated Services Digital Network (ISDN) refers to the

> simultaneous carrying of digitized voice and variety of data traffic on the digital transmission links and by the same digital exchanges.

Table VII shows the percentage of Narrowband ISDN coverage in the group of seven.

Table VII PERCENTAGE OF NARROWBAND ISDN COVERAGE FOR THE GROUP OF SEVEN

COUNTRY	1989	1990	1993	1994	1995
France	NA	100.0%	100.0%	100.0%	100.0%
Germany*	NA	NA	100.0%	100.0%	100.0%
Japan	69.0%	76.0%	92.0%	100.0%	100.0%
United States	.1%	.5%	NA	49.8%	NA
Canada	NA	NA	NA	NA	NA
Italy	NA	NA	NA	NA	NA
United Kingdom	NA	NA	NA	NA	NA

* Applies only to former West Germany.
SOURCE : NTIA Telecommunications in the Age of Information

ISDN can support voice, digital data, text, and image transmission services with a transmission capacity of 64 Kbps with two channels of voice and data, and a third for

signaling and data. International standards for higher capacity and data rates, Broadband-ISDN (BISDN), to support applications like high-speed computer communications, cable TV distribution plants, TV conferencing or Teletext are being developed. [STAL91]

c. Network Switching

Along with transmission systems, network switching equipment technical capabilities have been improved. The 1920s automatic **step-by-step** switching machine was replaced by the **cross-bar** systems and later by the **electronic** but still analog switches. The next step in the evolution are the **electronic digital** switches that offer lower cost per line. The percentage of Electronic Switches by subscriber lines in the group of seven appears in Table VIII.

Table VIII PERCENTAGE OF ELECTRONIC SWITCHES BY CO FOR THE GROUP OF SEVEN

COUNTRY	1989		1994	
	ELECTRONIC OFFICES %	RANK	ELECTRONIC OFFICES %	RANK
United States	92.6	1	98.2	2
France	84.6	2	98.7	1
Canada	68.5	3	96.3	3
United Kingdom	59.5	4	92.0	5
Japan	52.7	5	93.0	4
Italy	17.6	6	NA	
Germany	2.8	7	NA	

SOURCE : NTIA Telecommunications in the Age of Information

The **photonic** switches are the future technology. They reduce the need for optoelectronic conversions when switching the large volume of signals carried over fiber, by allowing optical and photonic switching.

d. SS7

An important element of a network development is its network signaling capabilities. In 1980 CCITT developed the standards for Common Channel Signalling System No. 7 (SS7), with revisions in 1984 and 1988 in order to provide an internationally accepted general purpose common channel signaling system.

The percentage of central offices with SS7 capability in the group of seven is shown in Table IX.

Table IX PERCENTAGE OF CO WITH SS7 CAPABILITY FOR THE GROUP OF SEVEN

COUNTRY	% SS7	1989 RANK	% SS7	1994 RANK
France*	47.6	1	100.0	1
Canada	8.4	2	60.2	3
United States	6.3	3	57.0	4
Unit. Kingdom	6.2	4	83.0	2
Germany	NA		NA	
Italy	NA		NA	
Japan	NA		NA	

* France Telecom achieved the 100% level in 1990
SOURCE : NTIA Telecommunications in the Age of Information

SS7, specially designed to be used in ISDNs, is the mechanism that provides "internal control and network

intelligence essential to an ISDN," by passing signaling information in a digital format. With common channel signaling, control messages are routed through the network to perform call and network management functions. SS7 permits more efficient use of the network, by separating the signaling function from the information carrying channel. [STAL91]

The above technological steps are definitely the current fields of international competition. But in a dynamic area such as telecommunications, they can also be fields for international cooperation. In the edge of the information century,

> Society can benefit from the creation of ideas only if they can be disseminated through the population, thus providing the spark for further creativity. [NTIA91]

International organizations can establish the standards, and government policies can create the incentives to promote the free flow of capital, technology and personnel, in a common effort to adapt to the rapidly changing marketplace and provide better satisfaction to the customers needs.

B. THE THREE BIG MARKETS

1. U.S.A.

The invention of telephone in 1876 completely changed the way people lived and worked until then. This machine was able to transmit voice over telegraph wire. At first the new machine was received without much interest. People saw few

practical applications for such an invention. Despite the criticism, Bell continued to work on his invention, and in 1877, along with his assistant Watson they

> formed the Bell Telephone Company to provide service and distribute telephones ... That year **six hundred** telephones were on line and telephones were being produced at a rate of **25 per day** [USTA91].

In 1885, the American Telephone and Telegraph Company (AT&T) was incorporated and the Bell companies almost monopolized the U.S.A. telecommunications market until the end of 1983. At this time with AT&T's divestiture of the Bell telephone companies the Bell System was dissolved and the U.S.A. telecommunication industry moved towards a free and high competitive market. According to United States Telephone Association (USTA) in 1990 there were in U.S.A. 138,059,000 access lines, 1,332 telephone companies, with construction expenditures U.S. $17,928,489,000 and operating revenues U.S. $90,109,252,000.

a. Telecommunications Policy

In most countries today the telephone service has been provided mainly on a monopoly basis by corporations or government associations within the telecommunication ministry. In the United States, telephone service always has been provided by private companies under the regulation authority of the FCC and state public utility commissions. Following a Pro-liberation policy, FCC seeks to obtain from the telecommunications infrastructure the highest profit at the

lower cost. This policy offers the subscriber the opportunity of a free choice among competing companies, generates new technology through investments and competition, allows the telecommunications market to adapt faster to consumers demands, and prices, truly reflect the real cost of products and services.

b. The Federal Communications Commission

The Federal Communications Commission was established by the U.S. Congress in 1934. It is an independent regulatory agency. Its purpose is to regulate

> ... interstate and foreign commerce in communications by wire and radio, so as to make available, so far as possible, to all people of the United States a rapid, efficient, Nation-wide, and world-wide wire and radio communication service with adequate facilities at reasonable charges...article 47 U.S.C.

In addition the Communications Act in 1934 gave FCC the responsibility for the formulation and implementation of telecommunications in United States and commercial broadcasting policy. To ensure the independence of FCC the Communications Act includes the following provisions:

- First, not more than three Commissioners may be members of the same political party.
- Second, Commissioners are appointed to staggered five year, terms.
- Third, Commissioners and employees of the FCC are not permitted to have a financial interest in any company that sells or manufactures telecommunications equipment, or in any broadcasting company. [FCC86]

c. Liberalization in the United States

Probably the major factor that contributed to the U.S.A. telecommunications industry enormous growth, is the revolutionary liberalized policy followed by FCC, mainly since 1950. The Hush-A-Phone case in late 1950's, concerning the Customer Premises Equipment (CPE) market, followed by the 1968 decision for the Carterfone are characteristic examples of the policy towards deregulation and free competition, followed by FCC. [CADWAL92]

In the late 1970's FCC canceled the remaining tariff restrictions concerning terminal equipment, by adopting the "Harm to the Network" standard. Following this standard the telephone equipment registered with the FCC must be tested, either by the manufacturer itself, or by an independent laboratory. For registration purposes, a technical documentation of the equipment complying with all the standards form has to be submitted, and in one or two months the equipment is permitted to enter the market. Under the same process, foreign firms are also allowed to apply directly to the FCC for registration. In the sector of Long Distance Services a similar liberalization policy establishing competition rules has been followed. [FCC86]

A major event under this policy was the divestiture or "break-up" of AT&T. The department of justice argued that AT&T had monopolized or attempted to monopolize, despite the U.S. antitrust laws, the telecommunications markets and

services. Following the AT&T's divestiture, the Bell Operating Companies (BOC) are not allowed to provide long distance services outside their Local Access Transport Areas (LATA), where they still are a local monopoly. The BOCs are obliged to follow certain restrictions on the services and products that they may provide, and they can't offer information services and produce manufacturing equipment. [CADWAL92]

d. A Better Customer Service

The results of such a policy are today obvious in the U.S. telecommunications market. The terminal equipment industry has grown and consumers have the option of buying their own telephone instrument and choosing the company they prefer. The free competition introduced to the market a great variety of special phones, with additional features and new functions. A greater range of services and a variety of telephone companies are now available for the customer.

More important, prices in CPE and in the rates for long distance services have dramatically declined. The average price for telephone systems has declined over 50%, and the price per line for PBXs over 20%. Since 1984, AT&T's interstate long distance rates have declined over 22%, with similar decreases for its competitors. On international service, rates reductions average more than 10%. [FCC86]

e. Telecommunications Services

The U.S. telecommunications industry is made up of more than 2,000 companies and 890,000 employees, which serve more than 108 million subscribers nationwide, with revenues exceeding U.S. $175 billion. The trends and forecasts for telecommunications services appear in Table X.

After AT&T's divestiture, the U.S. common carrier network has been divided in 161 LATAs with more than 15,480 CO switches,and 140 million access lines. Local and toll callswithin the LATAs are handled by the Local Exchange Carriers (LEC), while communications among LATAs are Long Distance Carriers (LDC) responsibility. As telephone rates continue to drop, domestic and international calling volume is increasing, with data communications traffic expanding at twice the rate of voice telephony.

Table X TRENDS, FORECAST IN U.S. TELECOMMUNICATIONS SERVICES

ITEM	1988	1989	1990	1991*	1992**
Operat. Revenues[1]					
Domestic	141,25	149,10	154,38	161,07	169,96
International	5,81	6,81	8,27	9,90	11,65
Total Employement [2]	917.70	900.50	921.50	887.60	861.90
Production Workers[2]	654.90	646.30	662.40	657.50	649.60
Avrg Earning in US $ [3]	13.83	14.14	14.37	14.71	14.99
No of Telephones [2]	248.10	262.0	273.40	284.60	296.80
Industry Price Index	99.0	101.20	100.50	99.0	101.10

* Estimate, ** Forecast. 1: Millions of Dollars, 2: Millions,
3: Earnings per Hour
Source : U.S. Department of Commerce, U.S.T.A.

f. Local Services

The local telephone services are steadily growing, following the population and business growth. For the past 10 years the average growth in the access lines number is about 3%, and revenues for local telephone services grew about 3.7% for both 1991 and 1992. Following the technological developments, LECs are changing their signaling systems to the newer SS7 System, and their old electromagnetic switching equipment to the new stored program control switching method, by using digital computer technology. Inside the LECs, CO based switching traffic systems within customer's premises have been developed, called Centrex services. Among their features are automatic call distribution and routing selection, CO based local area networks, network management and billing services, voice mail and audio conferring. The standards for ISDN implementation have already been developed, and the Centrex services will serve as the base for the transition to ISDN. During 1991, there were about 7 million Centrex lines, serving more than 20,000 businesses, and LECs revenues from Centrex services were about U.S. $1.4 billion. [USTA92]

g. Long Distance Services

In the long distance telephone market, because of the price competition, an important subject for the telephone carriers is price stabilization, in order to maintain strong

revenues. For that reason the increase rate in revenues is proportionately lower than the rate of growth in long distance telephone services. For 1991, revenues increased by 7.3% with an estimated 7.6% increase for 1992. Eight years after its divestiture, AT&T remains the larger carrier. Its market share fell from more than 80% in 1984 to less than 63% in 1991. Table XI. shows the total toll service revenues and the percentage of the market the largest long distance carriers in U.S. share. [USTA92]

Table XI TOTAL TOLL SERVICE REVENUES FOR U.S. LONG DISTANCE TELECOM. CARRIERS (IN U.S. $ BILLIONS)

ITEM	'84	'85	'86	'87	'88	'89	'90
AT&T	35	36,7	36	35,2	35,4	34,3	33,9
MCI	.17	2,33	3,4	3,94	4,89	6,17	7,39
U.S. Sprint			1,1	2,59	3,4	4,32	5,04
Metromedia/ITT	.16	.241	.28	.287	.379	.404	.381
Williams Group						.300	.376
Cable&Wireless		.146	.17	.18	.218	.275	.359
ATC	.72	.86	.12	.162	.178	.326	.342
Allnet/Lexitel		.309	.45	.395	.394	.334	.326
ALASCOM	.25	.271	.27	.262	.272	.278	.259
Others	.41	.639	.99	1,35	1,82	2,35	2,58
TOTAL LDC	39	42,6	45	44,7	47,4	50,9	52,1
AT&T %	90	86.3	82	78.6	74.6	67.3	65.0
MCI %	4.5	5.5	7.6	8.8	10.3	12.1	14.2
U.S. Sprint %	2.7	2.6	1.8	5.8	7.2	8.5	9.7

Note : In July 1986, GTE Sprint and US Telecom became US Sprint, Metromedia Com. and ITT merged during 1988, Allnet and Lexitel merged at the end of 1985.
Source : FCC, USTA

Microwave Communications Incorporated (MCI), U.S. Sprint and other carriers will continue to dispute AT&T's dominant role in the market share in 1992.

The Message Telephone Service (MTS), used to make direct dial long distance calls, is the largest category in the long distance services product market, reaching U.S. $27 billions and with an annual growth rate of 3.5%. The next largest segment in the U.S. market are the 800 and 900 numbers, with total revenues about U.S. $6.5 billions. Traffic from 800 services market is about the half of all long distance communications, with more than 700,000 subscribers and has a constant traffic growth. Problems in bill collection and the negative public perception in the 900 services market, diminishes its role in the market. [USTA92]

h. Transmission Media

Before the development of cost-effective fiber optic technology, the vast majority of transmission equipment for U.S. telecommunications was composed of copper based media and microwave radio. Along with satellite radio were currying the largest amount of traffic. Because of its declining costs and extremely high capacity, fiber optic transmission is replacing copper and radio transmission. Currently fiber optic transmission facilities are increasingly used in public and private, long distance, local exchange and cable networks. By

1994 the BOC's are planning to double the amount of fiber installed in 1989. [NTIA91]

In the fiber optics, according to a report released by FCC, in 1991, the long distance carriers added 12% more fiber cable to their networks. During the same period the RBOC's increased their fiber facilities in their networks by 38%. [NETWORLD3]

i. Future Trends

According to the USTA Network management, the development of new specialized telecommunications services and the globalization of the industry are the major future trends of the U.S. telephone industry. The Persian Golf conflict in 1991 created a strong demand for certain international services such as videoconferencing and concerns about the strategic and sensitive issue of integrity and security of the national network infrastructure.

For several years users demand higher speed data communications services on the public network and especially in terms of LAN connectivity. In the area of technology the Regional Holding Companies (RHC) will provide fast packet switching high speed frame-relay data services. Table XII. shows the BOC's plan to equip more than 24% of their switches and about 50% of their access lines with ISDN. [NTIA91]

The development of ISDN and the introduction of Broadband ISDN will allow local telephone lines to transport

high speed data and handle more than one voice telephone conversation at the time.

Table XII BOCS INTEGRATED SERVICES DIGITAL NETWORK

COMPANY	1989*	1994*	1989**	1994**
Ameritech	5.4	51.7	0.2	83.6
Bell Atlantic	2.0	52.1	0.02	90.0
BellSouth	1.1	13.8	0.03	52.0
NYNEX	0.9	4.1	0.05	27.0
Pacif/Nevada Bell	0.5	14.4	0.001	40.0
Southwestern Bell	0.8	12.5	0.1	32.0
US WEST	2.6	13.1	0.3	51.0
TOTAL	1.9	23.1	0.1	49.8

* % BOC Central Offices Equipped for ISDN
** % BOC Lines with Access to ISDN

AT&T is currently working on a project called Software Defined Broadband Network (SDBN), to carry voice, data, video and image traffic. SDBN technology is to be built on a Synchronous Optical Network transmission infrastructure, and it will use Asynchronous Transfer Mode (ATM) technology. It will be available in three versions: Data, Multimedia and Voice-Only SDBN Service. [WALL92]

Local telephone companies are working towards Fiber To The House (FTTH) and Fiber-To-The-Curb (FTTC) networks, but even though fiber optics compete with copper cable on a technical basis, in many cases it is still more economical to install copper rather than fiber. By the mid-1990's problems like powering a local fiber optic network and the optical

network interface unit near or on the customer's premises are expected to be solved so FTTH and FTTC will reach the residential customer on an economic basis. In government policy developments, during 1991, the Bell telephone companies were allowed to provide information services, and recently, July 16, 1992 the RBOC's were allowed to enter the cable television market. FCC's policy toward allowing RHCs more regulatory freedom will have an important long-term impact on the structure of the U.S. telecommunications industry. An effort to readjust the requirements imposed on AT&T will improve the competition among the long distance carriers.

2. Japan

Japan has the world's second largest telecommunication market, estimated about U.S. $13-14 billion in 1990 and one of the most advanced telecommunications systems in the world. Since 1985, Japan has significantly deregulated its telecommunication market. The Japanese Ministry of Post and Telecommunications (MPT) is still responsible though for the administration and the development of the country's telecommunications policies and regulations.

> The MPT's role under government's recommendations is to ensure the greatest benefits to the citizenry and users and to promote the balanced development of the telecommunications sector as a whole. [WHITEPAPER91].

The market may be open for domestic and international competition, but it is under the supervision of the MPT and

the Telecommunications Business Law (TBL), and foreign participation remains minimal.

During World War II the Japanese telecommunications services along with the whole Japanese industry and production were almost completely destroyed. In 1952 the Nippon Telegraph and Telephone Public Corporation (NTTPC) was founded, and in a few years succeeded in restoring the telecommunications industry, reaching 50 million subscribers in 1989 (the second largest telephone country behind the U.S.) and about 275,000 employees.

a. Development after 1945

In 1985 a new law came into effect, which made NTTPC a private corporation, working in a competitive domestic and international market, among with others telecommunications carriers. With the introduction of new technologies like optical fiber techniques, ISDN, local digital switching systems, and high-speed digital subscriber lines, the Japanese telecommunications local networks are rapidly evolving. By the year 1998 almost all local switching systems will be completely digital [YAMAG90].

According to the new law, Japanese telecommunications carriers are based on the ownership of transmission facilities, rather than by the type of service they provide (as in the U.S.A.). Carriers that own and control their circuits are defined as **Type I**.

The growth trend in the number of carriers in Japan during 1990 appears in Table XIII. [NTTREV91]

Table XIII JAPANESE TELECOMMUNICATIONS CARRIERS

Type of Carriers			Number of Carriers 1989	1990
Type I	Domestic	NTT	1	1
	New Carriers	Long-Distance operators	3	3
		Satellite Systems operators	2	2
		Regional operators	7	7
		Automobile-portable telephone oper.	13	16
		Radio pager operators	33	33
	International	KDD	1	1
		New Carriers	2	2
Total			62	68
Type II	Special Type II		28	29
	General Type II		813	913

Type II carriers are those that offer value-added services, using circuits leased from Type I carriers. They are subdivided in to two categories: **General Type II** and **Special Type II**. The first are companies that provide services to closed user groups and the later offer services to customers on a nationwide and international basis.

After NTT's privatization in 1985, Japanese telecommunications began to develop dramatically. In 1980 NTT and Kokusai Denshin Denwa (KDD) were the only two carriers for domestic and international service respectively.

For the fiscal year 1990, the results for type I carriers are seen in Table XIV. [NTTREV91]

Table XIV PERFORMANCE OF TYPE I CARRIERS IN JAPAN

CARRIER	OPERATING REVENUES	OPERATING EXPENSES	OPERATING PROFIT
NTT	5,958,400	5,379,500	414,300
KDD	240,700	223,800	26,000
Long-distance relay operators	304,200	256,600	31,300
Regional operators	35,000	38,800	-11,000
Automobile and portable operators	75,100	64,600	3,600
Radio pager oper.	37,900	35,100	2,700

To ensure the fairness and effectiveness of a competitive environment for all old and new domestic and international carriers, on March 30, 1990 the Japanese government decided on some measures and actions to be taken:

- 1. Internal restructuring into separate long-distance and regional divisions, with full and open accounting for each division.
- 2. Divestiture of mobile communications operations and
- 3. Early digitation, prevention of information misappropriation, and other measures. MPT is working that these measures are carried out [WHITEPAPER91].

Today NTT is the leading provider of domestic telecommunications services in Japan (the largest telephone company in the world with more than $44.2 billions of

operating revenues for 1990). New Common Carriers (NCC) possess 6.5% of the total domestic market and about 30% in cellular and paging market. In the international level, KDD is the main provider of international services and possess 89% of the market.

b. Standardization in Telecommunications

Due to the proliferation of advanced telecommunications services, standardization in communications systems and telecommunications in Japan became an urgent issue. In March 1991 the Telecommunication Technology Council released a report suggesting the following:

- 1. Establishment of a new standardization body in the International Telecommunication Union (ITU) encompassing wire and wireless telecommunications, to work in conjunction with the standardization activities.
- 2. Participation of more organizations in the ITU, to upgrade its activities in standardization, and greater contributions by domestic standardization organizations to international standardization activity.
- 3. A stronger Harmonization of Advanced Telecom. Systems (HATS) Committee, which conducts mutual connectivity tests.
- 4. Development of a comprehensive standardization plan based on guidelines on such matters as relative importance as areas needing standardization, the time table for establishment and revision of standards, and specific points of concern with regard to standardization.
- 5. Specific action in six areas: broadband ISDNs, personal communications, and mobile communications networks, private networks, intelligent networks, audio-visual communications, and network management. [WHITEPAPER91]

Japan adopted the five switching office classes for its long distance network thirty years ago. The five classes are:

- class 1 : Regional Center (RC),
- class 2 : District Center (DC),
- class 3 : Toll Center (TC),
- class 4 : End Office (EO) and
- class 5 : Satellite Office (SO).

These correspond to the five classes Regional Center, Sectional Center, Primary Center, Tool Center, and End Office described in [STAL91] used in U.S. by AT&T before 1984.

NTT is now rearranging the five classes into just two [TETS,RYOIC91]. At the moment the SO's switching functions will be transferred to the EO's, with the entire project to be completed by March 1998.

Current primary telecommunication services are the Plain Old Telephone Service (POTS), ISDN, and high-speed digital leased circuits. By the end of 1990 NTT owned 18,873 64 Kbps circuits. In June 1989 its ISDN network was connected to KDD's international ISDN and one year later a packet network became usable with NTT's ISDN. With the development and diffusion of more intelligent ISDN terminals, that work under international standards and with the digitization of the phone network, ISDNs optical fiber networks extend to the user, will develop rapidly.

NTT's Digital Loop Carrier (DLC) systems are developed in order to introduce new low cost effective services by developing metallic cables, optical fiber cables and radio.

Japan has a very high concentration of population over wide areas, with most of the customers being right next to the road. While other organizations propose FTTC, Japan is moving towards fully Optical Loop networks, by proposing FTTH as the best method to create loop networks, by installing optical subscriber networks and using BISDN [TETSRYOIC91]. NTT's goal is, by the end of 2015, to establish fiber links to every home.

c. Investment and Procurement Regulations

There are no import tariff rates for telecommunications equipment, and procurement policy is based on "open, fair and nondiscriminatory" principles, with no distinctions made between domestic and foreign companies. Cultural barriers to foreign products, Japanese hesitation to deal with foreign suppliers or partners, unless there is a long history of prior contact, and difficulties in changing the current status in many procurement contracts that are already in effect, give foreign firms difficulties in penetrating the Japanese telecommunications market. An example is U.S. import penetration, which account a for 90% of the total Japanese international procurement, is only about 4% of

the telecommunications market. NTT is a company that has no manufacturing branch, and purchases all its commercial use products from outside sources. International procurement rose about 32%, from $352 million to $465 million, by the end of 1990. However this number represents only 5% of NTT's total procurement.

d. Plans for the Future

For the near future and the early years of the 21st century, NTT visualizes the telecommunication industry as a result of social and the economic tendencies of our society, and the technical trends in information and communication industry.

In the 20th century microelectronics and computer software technology led the telecommunication industry. Based on this infrastructure, the future trends in information and communication technology will allow ultra high density and increased volume in semi-conductor memory elements and will create larger-size optical memory media and high-speed optical switch elements. NTT is working for an

> advance knowledge processing technology which mimics the intelligent functions of human beings, such as inference and learning [VIP90].

Finally technology achievements allowing machines to perceive voice, characters, and objects and to supplement the human being functions, the generation three-dimensional (3-D) images and the larger capacity transmissions with

increased mobility, characterize the future communication services.

Using advanced ISDN capabilities for high-speed, broadband and intelligence communications, NTT is now changing the

> quick installation of telephone sets upon application and automatic direct dialing spread to every region throughout the nation

slogans of 1970's.

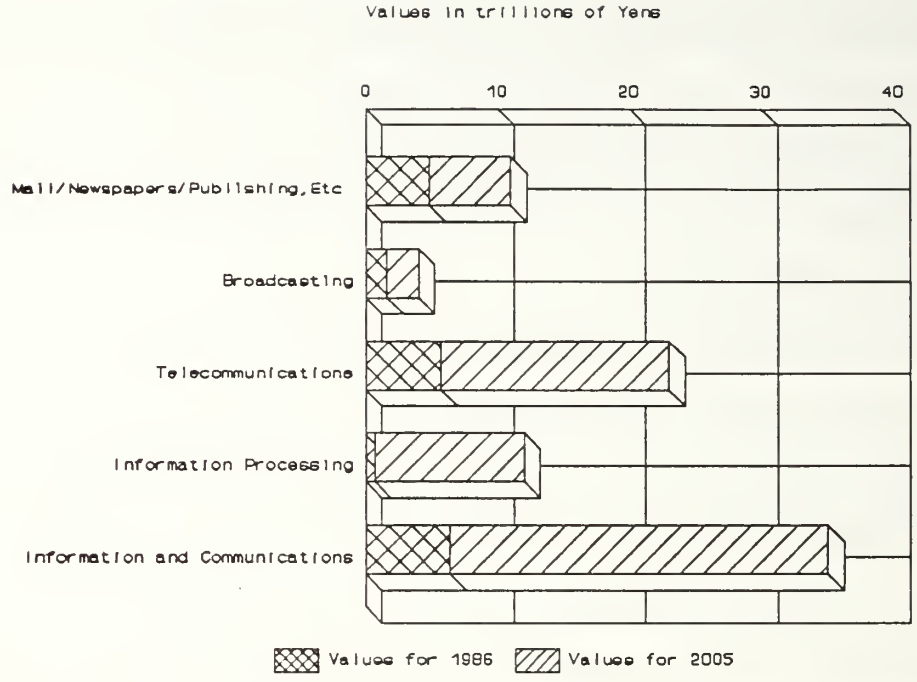
For the 21st century, company's plan is the Visual, Intelligent, and Personal services (VI&P) which offers

> a greater variety of services that are readily available anywhere and can be selected according to the personal preferences. [VIP90]

B-ISDN is the network that supports VI&P and handles voice, text, and video signals at the same time. It uses optical fiber to connect subscribers and consists of a high speed digital communications system for long distance transmissions and it is planned to be completed in 2015. Adapting to social and economic trends, following and in many cases leading the information and communication technology, Japanese information industry is rapidly growing. Table XV shows the projected market size of the Japanese information industry for 2005 in compare to year 1986. [VIP]

The 21st century companies will expand beyond national boundaries, trying to compete on international level. The need for valuable information production, correct and safe transmission and effective utilization around the world

Table XV PROJECTED MARKET SIZE OF INFORMATION INDUSTRY IN 2005 IN JAPAN



becomes more urgent. Because more women are entering the work force the Japanese family today is not centered around an adult male, but becomes "increasingly nuclear" [WHITEPAPER91].

All these, along with the rapid aging of population who want to contribute their part in the society in Japan (three times faster aging rate than people in the U.S.A. and Europe) and the constant increase in sensitivity for social and environmental problems, determine the guidelines of NTTs future telecommunications policy.

The main goals are for information and communication to provide more friendly and human services, that meet individualization and contribute to the solution of social and environmental problems in urban and country areas. In addition they provide reliable and secure services to improve management efficiency and bypass time, space and language barriers.

3. European Community

a. EC market

European Community (EC) was founded with the Treaty of Rome in 1957, by six founding members, Belgium, France, Italy, Luxembourg, Netherlands, and West Germany, in order to create the basis for a Common European Market. Today EC's twelve countries members, the initial six with the addition of Denmark, Greece, Ireland, Portugal, Spain, and United Kingdom, are working towards the creation of a single EC market by the end of 1992, by removing all physical, technical, and fiscal barriers to trade within the EC.

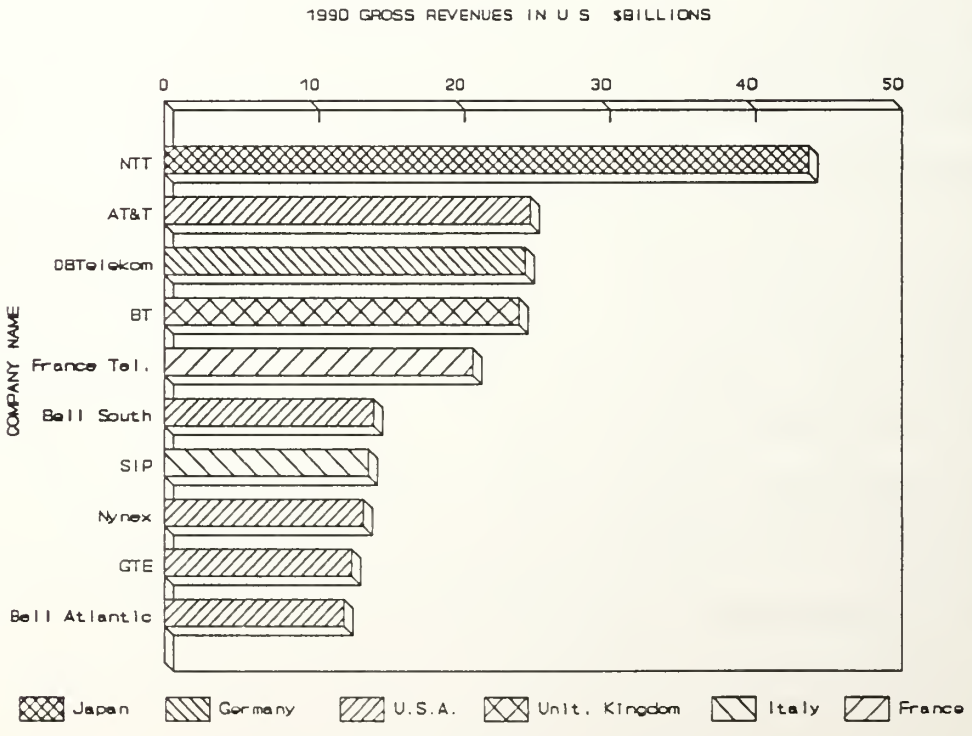
With the final unification of the European market EC can be considered a third big economic power equally compared to U.S.A. and Japan. In the telecommunications market, by the year 2000, 7% of the Community's GNP may derive from telecommunications, compared with just 2% today. By the end of the 20th century, 60% of all jobs inside the community will be dependent on telecommunications through information

technology integration. Also over the next 20 years the total public and private investment in telecommunications will be between ECU 500 - 1000 billion. (1 ECU is approximate equal to 1 U.S. dollar). According to the EC's report

> no single Community Country accounts for more than 6% of the world's telecommunications market whereas the United States represents 35% and Japan 11%. Taken as a whole the Community has a 20% world market share.

In 1986 world's telecommunications equipment reached U.S. $90 billion, where $17.5 billion were within the Community. Table XVI shows the world's top 10 telecom. equipment makers for 1990 (representing the 73% of the market) where EC's companies are presenting a total of $84.2 billion, U.S. companies $78.1 billion and Japan $44.2 billion. [BELL]

Table XVI WORLD'S TOP 10 TELECOMMUNICATIONS EQUIPMENT MAKERS (73% OF THE MARKET)



b. Need for a Common Perception

One hundred and fifty years after the invention of telegraph in the 1830s, the converge of telecommunications and computer technology, the digitization of telecommunications, the new transmission technologies with satellites and optical fiber, and the growth in services and applications, can not be satisfied by narrow minded national monopolies. Despite the different history, culture, and economic characteristics among its countries, Europe should follow the example of U.S.A. and Japan, who are deregulating their telecommunications industry, and find the best solution to a common, high competitive telecommunications market.

It is obvious to the EC Commission that the fragmentation of the European telecommunications market, which is made up basically of state operated monopolies, cannot lead to the 1992 goal of unification. A common telecommunications policy is needed, in order to integrate telecommunications equipment and services, and harmonize the European market.

The international developments in telecommunications industry, the technological advances, the continuous changes in the market needs, and the increased competition, overcome countries hesitations to financial and political control of the EC Commission over a very sensitive sector as the telecommunications. In June 1987, the publication of

> the Green Paper on the Development of the Common Market for Telecommunications Services and Equipment,

highlights EC's efforts for competitive telecommunications industry. The Green Paper is an effort to develop a common approach for the telecommunications development among the countries members, in order to improve the competitiveness of the European telecommunications industry. It includes

> proposals for action to stimulate liberalization and harmonization of member state telecommunications policies and markets. [USTA91]

Its main objectives are to give European manufacturers a continental base with the creation of a common internal market for equipment and services, and increase the competition within EC, in order to provide telecommunications services of greater variety, better quality, and at lower cost.

c. European Telecommunications Standards

International technical standardization in telecommunications is a major complex problem that needs to be solved in order for the new telecommunications services to become generally available, especially in Europe were national standards or different selections from international standards were applied by government monopolies. A situation like this narrows the boundaries of the market within the country's geographical limits, and decreases the chances for a reasonable profit of the industry. A common European telecommunications industry is very important for the final

economic development of the entire community and in order to succeed in selling equipment and services in a wider market, and survive in a highly competitive market, it has to adapt to the international standards. Directives and regulations have been published for standards for satellite TV broadcasting, the allocation frequencies for radio broadcasting and for public digital mobile communications, and the coordination and spread of ISDN and BISDN. Specially for the terminal equipment market, where new services continuously require a variety of types of terminals, the Community's regulation on mutual recognition of conformance tests for terminals, allows equipment to be tested by one set of tests in an approved laboratory, instead of twelve, before being presented to the market.

d. ISDN Standardization

The EC Council recommended in 1986 that EC's PTTs coordinate with each other to introduce ISDN and focusing in creating standards as early as possible and at the early stages, avoid development of different non-standard solutions by individual Member States. The goal is that the introductory phase for ISDN will be completed by 1993.

ISDN's implementation should be based on the current existing telephone network, without any fundamental changes, and should be used by both professional and residential subscribers.

> Digitation of existing lines by adding software and equipment - but without digging up streets and replacing wires - is estimated to cost 20 to 30% of investment additional to the ongoing digitation of switching and long distance lines while doubling the transmission capacity of existing subscriber lines. The ISDN concept must therefore be seen as a unique opportunity to upgrade Europe's existing capital stock in telecommunications into a high-quality network infrastructure for multiple use for both voice and data. [UNGERER88]

Based on CCITT and CEPT recommendations, an identical standard physical interface between ISDN terminals and the public network is used, for the CCITT's S or T references points. To succeed common design in terminals, the same terminal interface is also provided by PBX manufacturers. For the basic access (144 Kbit/s, two voice-grade channels of 64 Kbit/s plus 16 Kbit/s control channel) the public network termination and interface function is offered by the public network operator.

By the end of 1992, 5 million subscriber lines would be converted to ISDN, which correspond to 5% of the 118 million subscriber lines inside the Community. Also by the same period 80% of subscribers should be within reach of an ISDN capable exchange. [UNGERER88]

e. Inter-Institutional Integrated Services Information System

The geographical dispersion of Community's institutions and their daily contact with Member State administrations separated by considerable distances, the use of nine (9) official Community languages and the enormous

amount of documents produced, transmitted, filed, retrieved and archived every day, are the main administrations needs that make high-speed information services development urgent for EC's prosperity. [DIRGEN88]

The Inter-Institutional Integrated Services Information System (INSIS) is a user-driven program that was first introduced in December of 1982 by the EC's Ministers Council. Its purpose was to

> improve communication between the Member States and Community institutions by promoting the coordinated and harmonized exploitation of new techniques combining data and text processing and the use of telecommunications systems. [DIRGEN88]

To support the INSIS program, the User Advisory Committee (UAC) was created to determine needs and prepare proposals for integrated information systems. The committee's priorities were the further improvement in electronic transmission of written texts and electronic messaging, and the development of communication services to achieve easier and more coherent access to information of interest to the Community around the different computer data-bases. Also the establishment of videoconferencing facilities to reduce delivery delays, travel costs and save time, and horizontal integration of informatics services facilitate access to services and facilities for non-computer professionals.

f. Videoconferencing

The idea of holding meetings and conferences, using electronic systems and telecommunications technology combining technical and infrastructural facilities, without the need of the participants presence, is spreading worldwide. Although face-to-face meetings are often better and sometimes necessary, the need in both time and money savings, increases the use of videoconferencing in today's business and administration inside the community.

Videoconferencing is one of the projects presented and developed by the INSIS program in 1982. The initial idea was to create a video-conference service between the Community institutions in Brussels and Luxembourg. CEPT adopted the technical work already done by the European Videoconference Experiment (EVE) project and the European Videoconference Service was founded in its place, to promote the commercial and marketing aspects of videoconferencing in Europe.

The rapid technological progress of telecommunications industry and videoconferencing equipment, satisfied the need of introducing videoconferencing at the center of political decision-making in Europe. The capitals of the Member States were linked together and with the three locations of the Community institutions in Belgium and Luxembourg, in the same trans-Community network for videoconferencing. Special considerations have been taken to allow the use of all the different languages of the Community

and to impose different levels of encryption, given that many users will be high level EC's officials, dealing with sensitive matters. [DIRGEN88]

g. The STAR Program

Basic element towards the unification of the European market is the simultaneous and balanced development of telecommunications throughout the Community. The Special Telecommunications Action for Regional development program (STAR) was a five year program (1987 - 91) for the promotion of the economic development of the less favored regions of the EC, by improving access to advanced telecommunications services. It mainly concerns certain less-developed areas in seven Member States, France, Greece, Ireland, Italy, Portugal, Spain and United Kingdom. The STAR program was planned to be completed by October 1991, but its services will be extended until 1993 in order to develop telematic services in the entire Community. [DIRGEN91]

STAR's major areas of interest are the speeding up of digitization, earlier availability of ISDN, the linking of the less-developed regions of the Community with the advanced networks already existing, and the design of measures to stimulate the use of advanced services, mainly by small or medium size enterprises.

h. The TEDIS program

The Trade Electronic Data Interchange Systems program (TEDIS) is based on the idea of replacing paper documents with electronic processing and exchange of all commercial and administrative data. Other advantages of electronic transactions are the reduction of manual processing, the elimination of errors and delays caused by paperwork, the improvement of customer services and the speed up of sales, and independent from time zones 24 hour availability. [DIRGEN88] The transmission time and cost of a common commercial document in the Community are shown bellow.

Transmission Method	Time	Cost
Letter	1 to 2 days	ECU 0.3
Telex	30 sec to 5 min	ECU 0.6
Computer to computer	13 sec	
	switched	ECU 0.13
	automatic	ECU 0.01

The first phase of the program, from 1988 to 1990, had as objective the promotion of the awareness among potential users and equipment and software producers and the development of the Electronic Data Interchange (EDI) messages

in the areas of standardization, legal aspects, security, software and telecommunications requirements, etc.

> EDI combines the power of computers with that of telecommunications, to replace paper documents and serve as a data carrier for all commercial activities and services. It is the simplest way of doing business without paper, by making the computer systems of the trading partners correspond directly with one another.

Standardization and uniform treatment are necessary in order to avoid document disparity, formation of closed electronics networks and connectivity of the various sectoral networks now under development. [DIRGEN91]

From July 1991 until June 1994 the main objectives are the integration of EDI activities and promotion of information between sectoral projects, and exchange of information between working parties about general problems concerning all sectoral problems concerning standardization, security, legal aspects of EDI, and specific telecommunications requirements of EDI.

i. The ESPRIT program

The economic and public services growth in the Community depends on the development of advanced information technologies. The European Strategic Program for Research and development in Information Technologies (ESPRIT) is the biggest Community research and development program. It started on February 1984 and for a 10 year period is trying to stimulate the trans-border cooperation between European

industries, research centers and universities in order to improve their technological level.

j. The RACE program

The Research and development in Advanced Communications technologies for Europe (RACE) is a research program involving cooperation of national telecommunications organizations, industry research centers and universities. It started in January 1988 and its main objective is to set up an Integrated Broadband Communications (IBC) network based on existing ISDNs by 1995 - 2000. IBC reflects three different technological developments, the evolution in microelectronics, data digitalization, and satellites and optical fiber transmission techniques. By combining these techniques, the idea is to integrate in them other recent technological developments such as ATM, optical communications, coding techniques, or multifunction terminal architecture.

> The purpose of IBC is to have a single network of terminals, cables, node processors, computers, and satellites with a very high transmission rate. Such a network will provide integrated distribution of the traditional services (telephone, telex, etc.), the new services (color facsimile, high-quality videotext, electronic mail. etc.), conventional or interactive television programs, the ultrafast transmission of computer data, videoconferencing, high value-added services (financial services, electronic data interchange), etc. [DIRGEN91]

Besides its main goal RACE is also promoting EC's telecommunications industry, offers opportunities to service providers to improve cost performance, creates single European

market for IBC equipments and services,and develops the competitiveness of European network users. [DIRGEN88]

The RACE program definition phase, from July 1985 to December 1986 was dealing with the development of the IBC reference model and with the research related to the involved technology. The final decision on an initial IBC and on the strategies to be adopted for its introduction was made by mid 1989. By mid 1990 a set of systems architecture projects was defined, in order to be tested and validated by all member states. A final agreement on an IBC network architecture was reached by the end of 1991. Finally, IBC is planned to be given for market production by the end of 1995. The Telemed network is one of the future RACE program applications. The network connects hospital databases across the community. Other applications are the Resam project that provides remote expert support for aircraft maintenance, the Telepublishing project allowing remote publication of newspapers and books and the European Museums Network, which will connect 15 or more major European museums in a common telematics network. [DIRGEN91]

C. FUTURE TECHNOLOGY

1. Broadband ISDN

Broadband ISDN as defined by CCITT is a

> service requiring transmission channels capable of supporting rates greater than the primary rate.[STAL91]

BISDN's capacity as proposed by CCITT is designed to handle traffic with data rates up to 155.52 Mbps and 622.08 Mbps. It will be easily compatible with any already installed ISDN system. By implementing BISDN, services that require data rates beyond the ones delivered by ISDN, such as image and video processing, will become available. Along with BISDN, technologies which support these services, like optical fiber transmission systems and improved microelectronic circuitry will be developed.

According to CCITT classification BISDN will have two classes of service, **Interactive** and **Distribution**. Interactive services have the form of two-way communication where exchange of information can be done between a user and a service provider or between two users. They are divided in **conversational**, **messaging** and **retrieval** services. Distribution services have the form of one way communication, mainly from a service provider to a subscriber. They also are divided into two ways of services, **with** or **without user presentation control**. [STAL91]

2. Fiber in the Loop

In the recent years the need for more data and faster transmission is increasing. This need will become more urgent during the next decade. Because of its bigger capacity and bandwidth, optical fiber represents today the perfect and maybe the only feasible solution which can satisfy that need.

Many experts opinions but also telecommunications industry future trends are aiming towards bringing an optical fiber network as close to the subscriber as possible. The already installed copper network, which is translated in billions of invested dollars, represents the biggest problem to be solved.

The efforts to bring optical fiber closer to the user can be categorized as follows:

- 1. Fiber in the Loop (FITL). Carrying optical fiber systems from the CO to or near the customer premises.
- 2. Fiber to the Curb (FTTC). Extend optical fiber connections near but not at the customer premises.
- 3. Fiber to the Home (FTTH). Carrying optical systems all the way into the customer premises.

It is expected that by mid-1990's the cost required for fiber to be installed will outweigh the maintenance of the existing and the installation of new copper plants.

a. Lightwave multiplexing

In early 1980's Bell Laboratories developed a technique to put two or more signals on a glass fiber by using a system of lenses and a filter. By putting two or more wavelengths (colors) on each fiber, the currying capacity of glass fibers is increased. The system utilize light sources operating at 90 million pulses per second and at the early stages, 2,600 messages or data signals were able to be transferred simultaneously on one pair of fiber. [ITU91]

3. Solitons

The method of data transfer in optical fiber that appears to offer the most promising results currently being researched, is by using pulses of light called solitons. The data rates and transmission distances succeeded using soliton technology are impressive and constantly improving.

In 1991 AT&T Bell Laboratories demonstrated a soliton transmission at 32 Gbps through 90 km of optical fiber. NTT, the same year, succeeded to send soliton transmission of 10 Gbps over one million km of optical fiber. In late 1991 AT&T Bell Laboratories develop an optical fiber LAN using solitons and optical logic gates, capable of handling data and speeds up to 100 Gbps. [CADWAL92]

4. FDDI - II

The Fiber Distributed Data Interface is a 100 Mbps LAN, using optical fiber as medium and based on a token ring protocol. According to [ROSS89], FDDI-II is an enhancement to FDDI. It adds into the packet services of basic FDDI a circuit switching capability. FDDI-II can be considered as a network with 100 Mbps of available bandwidth, totally devoted to operation as a packet network. By integrating circuit switched services data traffic capabilities, portions of this bandwidth can be dynamically separated for use for circuit switched data. They can be allocated up to 16 wideband channels. These channels provide a bandwidth division mechanism between the

packet and isochronous traffic of 6.144 Mbps that corresponds to a 98.304 Mbps bandwidth.

Worldwide FDDI expenditures for 1991 were U.S. $181 millions. The predictions for 1993 are U.S. $640 millions and for 1995 U.S. $1,38 billions. In the next 10 years the widespread use of the basic FDDI will become the base for FDDI-II, which satisfies a much wider range of requirements.

V. CONCLUSIONS

A. SUMMARY

This thesis attempted to predict future trends in telecommunications by examining the current situation of telecommunications industry around the world and the efforts made by some countries to boost the information technology.

After a short presentation of different ways of communication, the current status of the world's telecommunications was presented. A number of statistical tables concerning telecommunications equipment and usage, form the basis of this section. The uneven communications services distribution around the world is obvious in this section. Many countries around the world, realizing the importance of telecommunications for their economy, are making significant efforts to follow the three big markets.

In an attempt to understand the future trends, the U.S.A., Japanese and European Community telecommunications markets were examined. Through different statistical information the current status of those three market is presented and the competition existing among them is projected. The main characteristics of those markets, besides the enormous economical and technological progress, are the policy of the open market competition followed by those countries and the

large amount of money spent for investment in the telecommunications industry.

Nations with a strong economic and industrial base are advanced in the provision, manufacture and processing of information. They understand the need to invest not only in technology improvement but also in technically trained manpower. They also realize that in the 21st century telecommunications cannot be confined by narrow minded protection rules and government regulations. Statistical data in chapter IV underline the efforts made by big telecommunications carriers around the world for future development, by investing in modern technology.

Another characteristic of world telecommunications is the unbalanced distribution of services throughout the world. ITU figures show that three quarters of the world's telephones are located in eight countries and only 7% in developing countries. 15% of nations account 90% of the world's TV receivers. 20 out of 158 ITU Member nations spent about 80% of the world's investments in telecommunications. Less strong and developed countries have the advantage of installing the latest and most modern technology according to their needs, without worrying about returns from previous investments in older technology. [ITU91]

B. RECOMMENDATIONS

Telecommunications today are probably the single most important factor determining economic and social progress of people and nations. With revolutionary techniques in transmitting and receiving information, like computer networks, fax, teleconferencing and B-ISDN, the speed and the quantity can no longer be considered as limiting factors. The enormous growth of the industry, with the entry of power firms from the electronics and aerospace and the deregulation and relaxation of imports controls imposes a free and competitive worldwide market.

In his opening speech at the World Communications Year 1983 conference Richard E. Butler said:

> Communications is an inexhaustible resource, an ever-growing technology which can greatly enhance the use of all the earth's resources, human and economic. Through a vast array of communication techniques mankind is able to accumulate, organize, and transmit information on a world-wide scale. Therefore, the harmonious and well-balanced development of an ever-closer-knit world communications network is a major historical event in keeping with the emergence of a collective awareness among mankind as a whole. Following its development, no-one should any longer be isolated from the national or international community. Communications should be a right and not a privilege.

These few words perfectly describe the need for telecommunications development around the world and the best way to succeed is through an open market and international cooperation. Communications today and for the near future are the key to the nations prosperity. Technology will keep to improve, and the ability of information and ideas exchange

offers people and businesses more opportunities for economic and social progress.

In an attempt to visualize the future we can predict that ISDN and B-ISDN applications will play an important role in 21st century's telecommunications. Following the Japanese example, the U.S.A. and Europe will move towards a fiber optic development up to the subscribers residence. Fiber optic technology will soon be able to provide under one source all information needed by the user. Telephone, computer, video, voice and HDTV will all be provided by one fiber optic cable. The near future in the U.S.A. will have competition among telephone and cable television companies. This will probably be expanded to other markets around the world. Mobile telecommunications will play a much more important role. As people travel more around the world and as the time becomes more valuable to everybody, the usage of cellular telephones and satellite telecommunications will increase. The next technology step will probably be a telephone device and a personal user number attached to the subscriber in his journeys around the world, rather than a machine stationed on a home desk.

All around the world, the need for better, faster, more accurate, up-to-date and cheaper information triggers the telecommunications industry. Poorer countries realize the importance of such an industry for their economy. The gap between the three big markets and the rest of the world will

gradually narrow, as more and more countries follow the strategy of a free open market that provides, through competition, a better customer service.

LIST OF ABBREVIATIONS

ANSI	American National Standards Institute
APT	Asia - Pacific Telecommunity
ASCO	Arab Satellite Communications Organization
AT&T	American Telegraph and Telephone
ATC	Advanced Telecommunications Corporation
ATM	Asynchronous Transfer Mode
ATU	Arab Telecommunications Union
BISDN	Broadband Integrated Services Digital Network
BOC	Bell Operating Companies
BT	British Telecom
CCIR	International Radio Consultative Committee
CCITT	International Telephone and Telegraph Consultative
CEPT	European Conference of Postal and Telecom.
CO	Central Office
CPE	Customer Premises Equipment
DACOM	Data Communication Corporation
DBP	Deutsche Bundespost
DLC	Digital Loop Carrier
EC	European Community
ECMA	European Computer Manufacturers Association
ECSA	Exchange Carriers Standards Association
EDI	Electronic Data Interface
EFTA	European Free-Trade Association
ETSI	European Telecommunications Standards Institute
FCC	Federal Communications Commission
FDDI	Fiber Distributed Data Interchange
FIPS	Federal Information Processing Standards
FITL	Fiber In The Loop
FTTC	Fiber To The Curb
FTTH	Fiber To The House
GNP	Gross National Product
HDTV	High Definition TeleVision
IBC	Integrated Broadband Communications
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronic Engineers
IFRB	International Frequency Registration Board
INTUG	International Telecommunication Users Group
ISDN	Integrated Services Digital Network
ISO	International Standard Organization
ITU	International Telecommunication Union
JTC	Joint Technical Committee
KDD	Kokusai Denshin Denwa
KTA	Korean Telecommunications Authority
LAN	Local Area Network
LATA	Local Access Transport Area

LDC	Long Distance Carriers
LEC	Local Exchange Carrier
LSI	Large Scale Integration
MCI	Microwave Communications Incorporated
MPT	Ministry of Posts and Telecommunications
MTS	Message Telephone Service
NCC	New Common Carriers
NIST	National Institute of Standards and Technology
NTIA	National Telecom. and Information Administration
NTT	Nippon Telegraph and Telephone
OECD	Organization for Economic Cooperat. and Development
OSI	Open Systems Interconnection
OTC	Overseas Telecommunication Corporation
PANAFTEL	Pan-African Telecommunications Network
PBX	Private Branch Exchange
POTS	Plain Old Telephone Service
PTT	Post Telegraph and Telephone
RASCOM	Regional African Satellite System
RBOC	Regional Bell Operating Companies
RHC	Regional Holding Companies (Bell)
SDBN	Software-Defined Broadband Network
SS7	Signaling System No 7
TBL	Telecommunications Business Law
TIRC	Telecommunications Industry Research Center
UAC	User Advisory Committee
USA	United States of America
USTA	United States Telephone Association
VAN	Value Added Network
VI&P	Visual Intelligent and Personal services
VLSI	Very Large Scale Integration
WARC	World Administrative Radio Conference
WATTC	World Administr. Telephone and Telegraph Conference

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